AN EXPERIMENTAL EXAMINATION OF CHILDREN'S SLEEP QUALITY AND IMPROVEMENTS RESULTING FROM A PARENT EDUCATION INTERVENTION

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Donna Golden Lee

Certificate of Approval:

____

Debra Cobia
Professor
Counselor Education,
Counseling Psychology, and
School Psychology

____

Joseph A. Buckhalt, Chair
Professor
Counselor Education,
Counseling Psychology, and
School Psychology

____

Robert Simpson
Professor
Rehabilitation and Special Education

____

Joe F. Pittman
Interim Dean
Graduate School

AN EXPERIMENTAL EXAMINATION OF CHILDREN'S SLEEP QUALITY AND IMPROVEMENTS RESULTING FROM A PARENT EDUCATION INTERVENTION

Donna Golden Lee

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AN EXPERIMENTAL EXAMINATION OF CHILDREN'S SLEEP

QUALITY AND IMPROVEMENTS RESULTING FROM

A PARENT EDUCATION INTERVENTION

Donna Golden Lee

Signature of Author

Date of Graduation

VITA

Donna Golden Lee, granddaughter of the late Richard Pierce and the late Agnes Monceaux Golden, was born October 22, 1971, in Mobile, Alabama. She graduated from Fairhope High School with honors in 1990. In June 1994, she graduated Cum Laude from Auburn University in Auburn, Alabama with a Bachelor of Arts in Psychology and a minor in Family and Child Development. She earned a Master's of Education with a focus on Emotional/Behavioral Disturbances in December 1995 from Auburn University. She worked as a consultative specialist and exceptional needs teacher for six years before pursuing her doctorate. While her area of focus was behavioral and emotional disturbance, she taught children identified with these and/or other exceptionalities including autism/pervasive developmental delay, mental retardation, specific learning disabilities, other health impairment, and students identified as gifted. She also worked with students identified as at-risk for drop-out. She has provided behavioral and consultative support to teachers, parents, and school administrators, as well as outside agencies and private institutions. She married Donald Andrew Lee, son of Samuel and Shirley Lee on November 7, 1998. On November 6, 2001, she gave birth to their first daughter, Daisy Makayla "Ayla" Lee. Their second daughter, Laci Isabella Lee, was born May 1, 2004. Donna earned a Master's of Education (Psychometry) in December 2003 and a Specialist of Education in School Psychology in May 2006 from Auburn University. She is currently employed by Auburn City Schools.

DISSERTATION ABSTRACT

AN EXPERIMENTAL EXAMINATION OF CHILDREN'S SLEEP QUALITY AND IMPROVEMENTS RESULTING FROM A PARENT EDUCATION INTERVENTION

Donna Golden Lee

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The role of sleep in neurobehavioral functioning has been extensively studied. Empirical evidence has shown that functions of learning, memory, and emotional regulation can be influenced by sleep. A large number of children do not get adequate sleep and the consequences of poor sleep manifests in poorer behavior and attention regulation affecting academic performance and achievement.

Using actigraphy and behavior scales, this study examined the sleep and behavior of six second-grade students before and after a parent sleep education program was provided as an intervention. Using a single-subject across multiple baselines experimental design, students were randomly placed in an order of receiving parent intervention. After one week of baseline, two families were provided the education program. After week two, another set of families received the intervention; after week three, the last set of families received the intervention. Teachers completed behavior rating scales for each school day during this 28-consecutive day study.

Data analysis by means of descriptive statistics and graphical display indicated long-term change in four of five variables measuring sleep quality for one of six subjects, three of five variables for two subjects, two of five variables for one subject, and one of five variables for two subjects. Improvement is also indicated by an increase in variable frequency of achieving/exceeding baseline mean post-intervention. Lastly, of the five subjects whose teachers provided daily behavior ratings measuring attention, two subjects were shown to average higher scores following intervention.

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Style Manual:

APA Manual

Computer Software Used:

ACTme Software

Analysis Software Package (ActionW2, 2002)

Microsoft Excel

SPSS 12.0 for Windows

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

According to the 2004 Sleep in America poll provided by the National Sleep Foundation, children in America do not sleep as much as experts recommend and a majority of children experience frequent sleep problems. The poll surveyed 1473 adults who were a primary caregiver or co-caregiver of a child 10 years of age or younger living within the same household, and found that a discrepancy exists in the number of hours children sleep and the number of hours parents think they should sleep. While the poll revealed that 69% of all children experience one or more sleep-related problems on a regular basis, only one in 10 parents thinks their child has a sleep problem. Of those, the poll found that many parents do not recognize their child's sleep problems as a concern which should be addressed (NSF, 2004).

Most sleep problems have been found to be exacerbations of normal sleep behavior caused by poor sleep hygiene, daytime stressors, or unusual sleep phenomena (Adair & Bauchner, 1993; Owens & Dalzel, 2005). This indicates a significant role for parent behavior in the development and maintenance of poor sleep in children.

As studies continue to identify and further define the function of sleep, decades of researching sleep have provided a body of knowledge on sleep, including the role of sleep in child development and the effects of poor sleep on human functioning and well-being (Bonnet, 1994; Pilcher & Huffcutt, 1996; Sadeh, Gruber, & Raviv, 2002). There remains a paucity of sleep studies with typically developing children of school age.

Normative values for objective measures of sleep for this group are sparse. Yet, practical conclusions can be drawn from what is currently known about sleep. Significant to health, behavior, learning, and quality of life, optimal functioning is dependent on healthy sleep.

The 2001 Transforming the Federal Role in Education so that No Child is Left Behind (No Child Left Behind) legislation calls to close the academic achievement gap between social class and ethnicity. This legislation includes measures to increase accountability for student performance, to focus on what works, to reduce bureaucracy and increase flexibility, and to empower parents. Now more than ever, standard test score results are scrutinized and effective, researched based programs and practices are being sought out. Educators and administrators are to help improve the academic achievement of the disadvantaged, increase parental involvement, create prevention and intervention programs for neglected, delinquent, or at-risk children, provide teacher training with evidence-based psychological principles into practice, and help unite psychological science with education. Parental education with regard to sleep holds much promise as a means to improve student performance.

Positive results have been shown with parent training in areas such as sleep patterns, behavioral entrainment, and intervention methods for infant sleep. Evidence also exists supporting the efficacy of empirically based behavioral treatments for young children and adolescent sleep problems (Mindell, 1999; Mindell et al., 2006). If children experience healthy sleep habits, research shows that mood, performance, and behavior are positively affected (O'Brian & Gozal, 2004). This suggests that treatment of sleep problems may lead to an improvement in academic achievement in school-age children.

The prominent role of sleep in child development coupled with the high prevalence of sleep problems experienced in school-aged children and the consequences of poor sleep underlies the need for research to learn more about childhood sleep, it's potential for change, and if parent education can positively affect child sleep.

LITERATURE REVIEW

In order to understand sleep's significant role during childhood and the need to determine if parent education with regard to sleep can influence the quality of sleep children experience, the following literature review will provide an overview of sleep, describe sleep as a biological rhythm and how this rhythm is associated with child development, describe underlying biological/physiological mechanisms which take place during sleep, effects of poor sleep, and prevalence of sleep disturbance experienced by children. Lastly, a review of sleep intervention studies will be provided.

Sleep Overview

Briefly defined, sleep is "a natural, periodic state of rest for the mind and body, in which the eyes usually close and consciousness is completely or partially lost, so that there is a decrease in bodily movement and responsiveness to external stimuli" (American Heritage Dictionary, 1992). During sleep, the human brain undergoes a characteristic cycle of brain-wave activity. Some brain regions show the same (or increased) activity as when awake and includes intervals of dreaming (Dahl & Lewin, 2002). Considered to be a behavioral state of the central nervous system (CNS), sleep can be described as an expression of CNS function, which has specific properties that reflect a particular mode of CNS activity (Groome, 1997).

In the 50 years of scientific study of sleep, a number of hypotheses have been generated on the functional significance of sleep. Theories have ranged from restorative, protective, and energy conserving in nature, to serving a role in central nervous system arousal, protein synthesis, and physiological maintenance. More recent theories include memory consolidation and synaptic reorganization of the cerebrum (Blumberg & Lucas, 1990). Technological advances in tools used to study sleep such as actigraphy, polysomnography (PSG) and neuroimaging techniques continue to guide theory and research and contribute to our understanding of sleep. While sleep continues to pose a biological enigma, its functional significance can be illustrated in animal experiments where sleep deprivation eventually results in death (Rechtschaffen, Gilliland, Bergmann, & Winter, 1983; Wozniak, 2000).

Sleep as a Biological Rhythm

Appearing before birth and continuing throughout life, sleep and wake states are characteristic to both humans and animals (Thoman, 1990). The cycling of sleeping and waking is one of many rhythmic patterns in life (Wolf, 1962). Changing behavioral and physiological processes that reoccur at regular (roughly 24-hour) intervals are referred to as circadian rhythms (circa=about; dian=day).

Circadian rhythms influence organization of activities into day and night cycles and the cyclic fluctuations associated with rest-activity cycles have been described to constitute a fundamental biological rhythm on which other daily rhythms are superimposed (Stern, 1969). All species, unicellular organisms to human, organize activities into day and night cycles, synchronizing physiological processes with the earth's rotation (Tankova, Adan, & Buela-Casal, 1994).

In humans, physical activity, sleep, body temperature, secretion of hormones, and more than one hundred other physiological processes are characterized by circadian rhythms (Carlson, 1992; Stoudemire, 1990). They operate according to internal hereditary biologic clocks and are thought to be entrained by time cues, particularly by cognitive and social zeitgebers (factors that give time) (Kalat, 1992).

As a child develops, patterns associated with these different rhythms change. With regard to sleep, age-related (developmental) processes exert profound influence. Total sleep decreases from 90% of a 24-hour period in infancy to just 8 hours per night by the age of 18 progressively taking on sleeping patterns characterized by shorter sleep duration, longer sleep cycles, and less daytime sleep as is characterized by adult sleep patterns (Dahl, 1996).

Spending approximately equal amounts of time sleeping during the day and night, a neonate's "biological clock" takes a few months to catch on to the 24-hour cycle. Advances in neurological development during the first 6 months enable infants to remain awake and alert for longer periods of time as their patterns of sleeping, crying and eating become more regular (Bee & Boyd, 2002; Olds & Papalia, 1992).

Gradually in the course of the baby's first year, a transition to a more regular pattern of eating and sleeping occurs (Dearing, 2001). This regularity of sleep patterns marks the development of the central nervous system's regulation of the circadian cycle of sleep and wakefulness (Sadeh & Anders, 1993; Thoman, 1990).

Research findings have shown that many children do not establish an early, stable sleeping pattern and up to 30% of children have sleep problems in their first 4 years (Futterman, Lacks, & Wolfson, 1992). Moreover, sleep disturbances during the first years of life tend to persist and may develop into a chronic disorder. When understood in terms of context, time, and development, this is concerning. During the first 5 years of life, during the developmental period where the brain triples in size to reach 90% of adult size and achieves exceptional complexity in cognition, socio-emotional development, language, concept of self, and physical skills, a child spends more time asleep than awake (Chugani, Phelps, & Maziota, 1987; Cicchetti & Beeghly, 1990; Kagan, 1981). Thus during this significant developmental period which spans childhood, sleep is arguably the primary activity of the brain and appears to serve a central role during development (Dahl, 1996).

While much attention has been paid to a large number of factors during waking that relate to cognitive development, account for individual differences, and propel developmental change, sleep's robust presence in childhood is not coincidental and the establishment and maintenance of a stable sleeping pattern is essential for optimal development. Attention to factors which take place during sleep will provide a better understanding of sleep's significant role in human development and functioning.

Biological/Physiological Mechanisms of Sleep

In 1953, Aserinsky and Leitman identified two distinct sleep stages: REM sleep (Rapid-eye movement or dream sleep) and non-REM sleep, which are now generally accepted to frame the basic architecture of sleep. During sleep, we alternate between REM and NonREM phases of sleep. According to the National Sleep Foundation (on-line), "sleepers go back and forth through various stages of sleep, all of which produce noticeable changes in brain activity and other physiological functions."

We begin our nights with NREM sleep. NREM sleep is comprised of four phases which correspond to progressively deeper levels of sleep. In a healthy and well-regulated individual, it takes 3-15 minutes after one closes their eyes to enter Stage 1 NREM sleep.

It is in this stage that one will sometimes experience myoclonic contractions, or little jerks associated with the impression of falling. Sleepers are easily awakened during this stage of sleep and if awakened, may not realize they were asleep. Once Stage 1 NREM is established, sleepers move towards Stage 2 NREM sleep. Lasting 10-15 minutes, this stage is still relatively light but produces bigger spikes in brain waves than Stage 1 NREM. After Stage 2, sleepers move to Stage 3 and then Stage 4 NREM sleep. Stages 3 and 4 NREM are also called delta or slow-wave sleep and represent the deepest sleep in humans. As Dahl (1996) notes, "It is during this slow-wave sleep, (usually 1 to 3 hours after going to sleep) that it is extremely difficult to arouse children and if aroused, children appear disoriented, confused, and are cognitively slow." Sleepwalking, talking, and night terrors are usually associated with this stage of sleep. The length of deep delta sleep is regulated by the wake state. "It increases in proportion to how long one has been awake and further increases (and becomes even deeper) following sleep loss or chronic sleep disturbances (as a deep "recovery" sleep)" (Dahl, 1996).

Delta sleep is followed by REM sleep, also called paradoxical sleep because it has aspects of both deep sleep and light sleep. This stage of sleep is characterized by rapid eye movements and paralysis of muscles other than those controlling the eyes and those maintaining breathing. It is also characterized by intense neural activity, an increase in blood circulation, and an increase in the use of oxygen. Dahl and Lewin (2002) describe the paradoxical nature of this stage of sleep:

> On one hand, REM appears deep because the changes in the body (loss of muscle tone) and subcortical brain systems, such as temperature regulation and control of respiration and heart rate, are more profound than in any other stage of

> sleep. On the other hand, higher cortical brain functions are associated closely with REM sleep. Further, it is relatively easy to awake a person from REM sleep (alertness returns relatively briskly, compared with deep non-REM sleep). (p6)

In a healthy, well-regulated individual, the longest and most intense REM periods are described to occur just after the body temperature reaches a minimum (around 5 am). When a person is awakened from REM sleep, alertness returns relatively fast. After REM sleep is over, the sleeper goes back to stage 2 NREM to begin the cycle again. A complete cycle lasts approximately 90 minutes and occurs four to six times throughout the night (Dahl, 1996).

Like the development of regulation of the circadian cycle of sleep and wakefulness, sleep architecture and stage distribution are also influenced by maturation changes and age. Children have extremely large amounts of deep, slow-wave sleep. This high proportion of slow wave sleep peaks in early childhood and then decreases dramatically after puberty, and continues to decline over the lifespan. As well, there is a dramatic decrease in the proportion of REM sleep from birth (50% of sleep) through early childhood into adulthood (25-30%) (Carskadon, 1982).

In addition to changes in brain waves during each stage of sleep, The National Sleep Foundation describes some of the important biological/physiological mechanisms which occur during sleep:

> During sleep, the body secretes a number of necessary hormones that affect growth, regulate energy, and effect metabolic and endocrine functions. For example, near the end of the sleep period, the body secretes the stress hormone cortisol, which stimulates alertness. Sleep is also the time when growth hormone

is secreted, which drives childhood growth and plays an important part in regulating muscle mass in adults. Further, the sleep cycle affects secretion of the hormone, leptin. This hormone tells the body when it should feel full and thus, has a direct influence on appetite and weight. (http://www.sleepfoundation.org)

What is important to note here is that there appears to be a very specific pattern to these processes, as when or what stage of sleep specific physiological or biochemical processes occur. Further, sleep characteristics including continuity, timing, and patterning of different stages of sleep are described to affect these processes. If sleep is repeatedly interrupted and one cannot cycle normally through REM and NREM sleep, sleepiness or fatigue will be experienced during the day (Dahl & Lewin, 2002). If sleep gets interrupted at night or gets cut short in the morning, or even if one sleeps many hours in short pieces of interrupted sleep, consequences of sleep dysfunction will be experienced. Consequences to cumulative sleep deprivation without cycles of REM and NREM can include depression, confusion, memory loss, extreme mood swings, anxiety, hyper-somnolence, hallucinations, and other personality changes (Hobson & Pace-Schott, 2002). So, while the function of sleep continues to be scientifically unraveled, we know that there are specific biological/physiological mechanisms which occur during sleep whose regulation are affected when one has poor, insufficient or interrupted sleep.

Effects of Poor Sleep

The effects of inadequate and/or disrupted sleep on children's health, behavior, learning, cognition, emotional well-being, and quality of life can be serious and pervasive (Owens & Witmans, 2004; Wolfson & Carskadon, 2003). Inadequate or disturbed sleep results in significant daytime sleepiness for children and adolescents and significant performance impairments and mood dysfunction are associated with daytime sleepiness (Fallone, Owens, & Dean, 2002; Owens & Witmans, 2004). Sleepiness has been associated with child functioning in such domains as inattention, poor concentration, hyperactivity (Chervin, Dillon, Bassetti, Ganoczy, & Putich, 1997; Epstein, Chillag, & Lavie, 1998), poor school performance (Wolfson & Carskadon, 2003), impaired cognitive test performance (Buckhalt, El-Sheikh, & Keller, 2007), poor performance on standardized achievement tests (El-Sheikh, Buckhalt, Cummings, & Keller, 2007), and irritability and aggression (Dahl, 1996).

Inadequate sleep results in mood deterioration, decreased arousal, difficulties with focused or controlled attention, and fatigue. In addition, irritability and decreased threshold for negative emotional responses such as anger and frustration are also often associated with sleep deprivation (Dahl 1996). As reported by Owens and Witmans (2004):

> Mood problems in children with sleep disturbances are virtually universal, particularly exacerbation of negative mood and equally importantly, a decrease in positive mood or affect. The regulation of mood, or the use of cognitive strategies to modulate and guide emotions, appears to be affected by sleep quality and quantity. (p.155)

Furthermore, Dahl and Lewin (2002) note that there is “mounting evidence that sleep deprivation has its greatest negative effects on the control of behavior, emotion, and attention, a regulatory interface that is critical in the development of social and academic competence, and psychiatric disorders” (p. 175). Both subjective and objective measures have found that children who are characterized as poor sleepers show increased incidence and severity of behavioral difficulties; with more disturbed sleep measures, more altered behavior is found to be observed (O'Brian & Gozal, 2004).

Poor, insufficient, or disorganized sleep has been linked to poor academic performance (Epstein, Chillag, & Lavie, 1998; Gozal, 1998; Randazzo, Mueuhlbach, Schweitzer, & Walsh, 1998; Wolfson & Carskadon, 1998). School-age children's performance in school is greatly affected by their quality of sleep, duration of sleep, sleeping patterns, and their sleeping behaviors. In their 2002 study, Sadeh, Raviv, and Gruber found significant correlations between poorer sleep-quality measures, lower performance on neurobehavioral functioning measures and higher rates of behavior problems in school age children. Wolfson and Carskadon (1998) found that students who described themselves as struggling or failing school (Cs, D's, and F's) reported that on school nights they obtained about 25 minutes less sleep and went to bed an average of 40 minutes later than those students who described themselves as A & B students.

It must be noted that causal relationships between sleep problems and children's well-being appears to be bidirectional (Dahl, 1996; Sadeh 1996). Sleep problems can be indicative of child psychopathology or stress, and psychopathology can result from or be exacerbated by poor sleep (Sadeh, Raviv, & Gruber, 2000). Agreeing, Dahl (2002) notes:

> It is essential to underscore the overlap between sleep regulation and behavioral/emotional problems in children and adolescents because there is a clear two-way interaction between these systems. The development, regulation, and timing of sleep can be altered by behavioral/emotional disorders, and cognitive, behavioral/emotional control during daytime hours can be influenced by the way children and adolescents sleep. (p181)

Owens and Witmans (2004) report that even among special populations where the clinical symptoms of any primary medical, developmental, or psychiatric disorder are likely to be exacerbated by comorbid sleep problems, improving sleep has the benefit of improving clinical outcomes. For instance, treatment for sleep problems has been found to improve ADHD symptoms in children identified with ADHD (Dahl, 2002; Mullane & Corkum, 2006; Cohen-Zion & Ancoli-Israel, 2004).

Sleep restriction and extension research has provided support to the efficacy of sleep intervention on performance. Sadeh, Gruber, and Raviv (2003) restricted or extended children's sleep by one hour over three nights. Measuring cognitive functioning with the Neurobehavioral Evaluation System, results showed that moderate changes in sleep duration to have significant positive effects on children's neuropsychological functioning suggesting that most children can benefit from even modest sleep extension. Likewise, a within-subjects experimental design with one week of baseline, one week of sleep restriction, and one week of sleep optimization, found that when sleep was restricted, children were rated by teachers to have more academic problems compared to the other conditions and more attention problems compared with the baseline condition (Fallone, Acebo, Seifer, & Carskadon, 2005).

Prevalence of Sleep Problems

Reported prevalence rates of sleep problems have ranged from less than 5% to 43% in school-aged children (Mindell, Carskadon, & Owens, 1999; Ohazon, Roberts, Zulley, Smirene, & Priest, 2000; Stein, Mendelsohn, Obermeyer, Amromin, & Benca, 2001; Rona, Gulligord, & Chinn, 1998; Kahn et al., 1989). Until recently, it has been difficult to provide accurate estimates of the prevalence of specific sleep problems in the school-age child because most studies have used either subjective reports or the criteria used to identify the exact nature of the problem were not well defined. For instance one study reported prevalence rates lower than 5% (Rona, Gulligord, & Chinn, 1998) while Owens, Spirito, McGuinn, & Nobile (2000) reported 37% and Archbold, Pituch, Panahi, & Chervin (2000) reported rates as high as 41%.

The more recent use of objective measures such as actigraphy to measure sleep, has provided more accurate estimates of the number of children experiencing sleep problems. Activity-based monitoring has been established as a valid and reliable method of assessing sleep-wake patterns in children and adolescents. Agreement rates between acticgraph measures and concurrent polysomnography (PSG) range from 78 to 90 percent for children, adolescents, and adults. In addition, studies have shown that actigraphy paired with parent sleep diaries and reports can provide an accurate picture of sleep duration and quality (Acebo, et al., 1999; Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991; Wolfson et al., 2003).

By measuring nighttime movement, actigraphy provides a variety of different objective parameters, including sleep onset latency, estimation of true sleep time, and fragmented sleep. With the use of actigraphy, Tikotzky and Sadeh (2001) determined that 41% of a sample of kindergarten children were poor sleepers according to at least one actigraphic criterion, and 29% had true sleep time lower than 90% (of time in bed). Another study using actigraphy showed that 18% of a community sample of 7- to 12-year olds manifested fragmented sleep, meaning sleep that is intermittent or noncontinuous throughout the night. One important finding from this study is that for most of those children identified with significant sleep problems, no sleep problem was identified or reported by the parents or the children themselves even after a follow-up inquiry (Sadeh, Raviv, & Gruber, 2000). In a study of 600 eight-year-olds, regular delay of sleep onset was reported by 45% of children and only 17% of their parents (Gregory, Rijsdijk, & Eley, 2006).

Like the 2004 Sleep in America poll, these latter two studies illustrate how many parents do not recognize their child's sleep problems or if they do, they do not think it is an issue to be addressed. In addition, parents may know when their child goes to bed but are not aware when they actually go to sleep or if they wake during the night. In fact, older children are less likely to draw somebody's attention to their sleep problems (Anders, Carskadon, Dement, & Harvey, 1978).

Most school-age children between 5 and 12 years old need between 10 and 11 hours of sleep (National Sleep Foundation, 2004). Daytime sleepiness in an elementary school–age child is indicative of significant sleep problems because physiologic alertness levels in this age group are normally very high (Owens & Witmans, 2004). For the school-aged child, the most common sleep problems include difficulty falling asleep, nighttime awakening, snoring, stalling and resisting going to bed, having trouble breathing, and fatigue complaints (Blader, Koplewicz, Abikoff, & Foley, 1997).

Children with developmental disorders (Autism, Pervasive Developmental Disorder, and other neurobehavioral disorders) have been shown to be more likely to exhibit disorganized or disturbed sleep than other children (Piazza, Fissher & Kahng, 1996; Quine, 1991, 1992; Wiggs & Stores, 1996a, 1996b). As a result, they may be at risk for compromised neurobehavioral functioning contributing to the academic difficulties experienced by some of these groups (Sadeh, Gruber, & Raviv, 2002).

Causes of Sleep Problems

School-age children in the United States and other technologically advanced countries are at risk for sleep problems due to a wide variety of cultural and psychosocial influences. Performance demands resulting from participation in a range of activities outside of school influence healthy sleep habits. Many school age children participate in after school programs and extracurricular sports and activities. In addition to such social/performance demands, demands and characteristics of home life may also contribute to poor sleep hygiene. Days are busier and not always consistent with time home, dinner, and bedtime routines. Household characteristics such as high levels of disorganization, crowding, and conflict are not conducive to good sleep. Cultural influences such as sleeping arrangements, appropriate sleeping patterns, and bedtime rituals also influence child sleep. Buckhalt, El-Sheikh, and Keller (2007) found that actigraphic measures for children's sleep quality, duration, and variability in sleep schedules were related to a child having his or her own room as well as the number of persons who shared the child's bedroom. Further, many children have television, radios, telephones/cell phones, and computers in their bedrooms. Research has found that the availability of such contemporary technological devices contribute to poorer sleep habits in children (Owens, Maxim, & McGuin, 1991; Van den Bulck, 2004).

A number of dominant sources of psychosocial influences outlined by Sadeh, Raviv, and Gruber (2000) included:

> (a) Parental characteristics, personality, psychopathology, education, and parenting skills (Morrell, 1999; Rona et al., 1998; Sadeh & Anders, 1993; Van Tassel, 1985); (b) psychosocial stress and trauma; (for reviews, see Moore, 1989; Sadeh, 1996) and (c) cultural and social demands and attractions, school, work, and entertainment (Carskadon, 1990; Wolfson, 1996; Wolfson & Carskadon, 1998). (p.292)

In a review of the literature, Adair and Bauchner (1993), found that most sleep problems are either exacerbations of normal sleep behavior caused by poor sleep hygiene or daytime stressors or unusual sleep phenomena. They found that sleep-related problems are infrequently caused by unsuspected neuropathology such as seizures or narcolepsy. Sadeh, Raviv, and Gruber (2000) found that sleep quality measures (sleep percentages and number of night wakings) were associated with the parents' education and family stress. Children of parents with higher education level had improved sleep quality. Conversely, increased family stress was associated with poorer sleep quality.

Sleep Intervention Research

Over the last two decades, researchers and clinicians have developed a number of intervention strategies for bedtime behavioral issues, night wakings, and child/adolescent insomnia, including behavioral management techniques, parent education and medication (Mindell et al., 2006). While there is a paucity of experimental studies on the effectiveness of parent intervention on school-age child sleep problems, evidence exists for empirically based behavioral treatments for infant and young children as well as approaches for adolescent sleep problems (Kuhn & Elliott, 2003; Mindell 1999, Mindell, et al., 2006; Owens 1999).

Behavioral treatments have included ignoring procedures, bedtime routines, scheduled awakenings, sleep restriction, and parent education. In their 2006 review, Mindell and colleagues report extinction techniques and preventative parent education to be most strongly supported by evidence-based research. For the purpose of this review, research investigating the effectiveness of bedtime routines, parent education, and compliance and experimental success with imposed sleep schedules is examined.

Bedtime Routines. To reduce tantrum behaviors, the development of positive bedtime routines as an alternative to ignoring was investigated (Rapoff, Christophersen, & Rapoff, 1982). Participants in this study included three developmentally delayed children ages 2, 4, and 15. The researchers found positive routines increased cooperation in going to bed, reduced the number of minutes past the appropriate bedtime, and reduced the duration of in-bed crying with all three children. In another study, bedtime routines and graduated extinction (gradually longer and longer periods of ignoring) was compared for their effectiveness at reducing bedtime tantrums. In this study, 36 children were randomly assigned to one of three groups: routines, graduated extinction, or control. From parental reports, children in both treatments groups had tantrums less often and for shorter periods of time than the control children, but routines produced the fastest improvements (Adams & Ricket, 1989). Using positive routines and sleep restriction in order to reduce bedtime disturbances and night waking, Christodulu and Durand (2004) examined the effectiveness of positive bedtime routines and sleep restrictions with four young children with developmental disorders who experienced significant sleep problems. Results showed that bedtime routines and sleep restriction were successful in eliminating bedtime disturbances and nighttime awakenings with all four subjects.

Parent Education. Efficacy of parent education on child sleep has shown promise. A majority of studies have been preventative in nature and show that parent education in child sleep does, in fact, make a difference. Three large studies have demonstrated the efficacy of parent education for the prevention of sleep problems.

Wolfson, Futterman, and Lacks (1992) randomly assigned 60 first-time parents enrolled in childbirth classes to a sleep training group or a control conditioning. The training group received four training sessions, two prenatally and two post birth. Utilizing parental diary data, they found at age 6-9 weeks, infants in the parent training group slept significantly better than children in the control group.

Adair, Zuckerman, Bachner, Phillip, and Levenson (1992) also demonstrated the efficacy of an education prevention program based on behavioral strategies. One hundred and sixty-four consecutive infants presenting at a 4-month health visit comprised the intervention group and were compared to 128 historical controls. At 9 months, the control group was twice as likely to wake during the night compared with the intervention group.

Lastly, Kerr, Jowett, and Smith (1996) found that parents of 3-month olds who were provided information about sleep issues had significantly fewer sleep problems at 9 months than a control group. The 169 children were randomly assigned to the intervention or control group. The parental intervention was provided both verbally by a researcher, and through written materials.

Parent education with regard to intervention has also shown success. Rapoff, Christophersen, and Rapoff (1982) studied the effectiveness of the use of management procedure guidelines for child sleep problems. In this study, nurse practitioners offered the management procedure guidelines during a single clinic visit and gave parents a written handout which described procedures for managing bedtime problems. Results showed that three of the six subjects showed a decrease in the rate of bedtime resistance (crying and whining) following treatment.

Imposed Sleep Schedules. Some evidence exists for compliance and experimental success with imposed sleep schedules. Sadeh, Gruber, and Raviv (2003) found that given a small incentive, most children can extend or restrict their sleep period on demand. In another study, an assessment of compliance and experimental success with imposed sleep schedules among healthy children was completed. Fallone, Seifer, Acebo, and Carskadon (2002) asked children to follow assigned sleep schedules at home. Students were scheduled optimized (at least 10 hours time in bed per night) and restricted (6.5 to 8 hours in bed per night) sleep conditions across a 2 week period during the school year. Using continuous actigraphy and parent report of bedtime, researchers found children as young as 6 years of age were able to maintain substantial changes to their usual schedules across several nights at home.

Purpose of this Study

The increasing emphasis on accountability for schools has driven the field's desire to seek new ways to help children do their best in school. This emphasis amplifies the importance of bridging science and education. Research implies that not only are children in America not getting the recommended amount of sleep, but they are also experiencing other sleep problems as well. The literature supports that insufficient or poor sleep results in poorer behavior and attention regulation directly impacting academic performance and achievement. Conversely, research also shows that good sleep hygiene can foster healthy sleep which positively influences mood, performance and behavior.

The National Sleep Foundation, in its 'Call to Action' recommends that parents and caregivers make sufficient sleep a family priority, embrace good sleep habits, learn to recognize sleep problems, and to talk with the pediatrician regarding sleep. Research has established that parents have a profound influence on their children's sleep habits. Owens and Witmans (2004) offer some basic principles of sleep hygiene for both the child population and adolescent population. All principles such as routine setting, bedroom environment, child diet and exercise are under the direct control of parents. If parents are made aware of these principles, of the recommended hours of sleep, learn to recognize sleep problems, and the consequences of poor sleep, will child sleep be affected? Will child behavior be affected? It was hypothesized that a parent intervention in the form of sleep education would influence parent behavior resulting in positive changes in child sleep amount and quality and higher teacher ratings on measures of attention.

Much of what is known about sleep is based on adult sleep and adult sleep disorders (NIH, 2003; Presman & Orr, 1997). A number of studies have focused on infant and early childhood sleep, both normal and impaired, but less research has been done with school-age children, and even less with typically developing, healthy children (Mindell, Owens, & Carskadon, 1999). Normative values for objective measures of sleep for typically developing children are sparse. To date, most studies using school-age children have been outcome or correlational in nature with only a few experimental designs. Of those experimental designs, few have been developed to measure sleep changes with relation to an intervention program.

METHOD

Participants

Six second-grade students participated in this 28-consecutive day study. The Institutional Review Board for the Protection of Human Subjects (IRB) at Auburn University approved the study. Three students were male; three students were female. One male was identified as being diagnosed with ADHD and took 54 mg of Concerta daily. Another male was identified as taking 18 mg of Concerta for ADHD-like symptoms but was not diagnosed with ADHD. All students were of Euro-American ethnicity.

Measures

Actigraph. Actigraphs are small solid-state computerized movement detectors which continuously register body movement. Activity between bedtime and wake time was monitored, and daily sleep diaries were completed by the parents to cross-validate sleep start and end times. The actigraph was an Octagonal Basic Motionlogger (Ambulatory Monitoring Inc., Ardsley, NY), a small and lightweight (45g) sleep device the size of a wristwatch. Motion during sleep was continuously monitored by the actigraph in 1-min epochs using zero crossing mode.

Sleep schedule measures were: (a) SOT, Sleep Onset Time - the first minute of three consecutive minutes of sleep as indicated by the Sadeh Algorithm; (b) DUR, the entire sleep period duration (in minutes) from sleep onset to sleep and end time; (c) SEF, sleep efficiency defined as time spent asleep out of the total sleep period; and (d) WAKE, the number of awakenings longer than 5 minutes. Sleep quality was determined using measures of efficiency, awakenings, and motor activity. Sleep quantity was measured using values of total sleep minutes (the minutes scored as sleep by actigraphy) and sleep duration (time in bed).

Sleep Diary. In order to document time to bed at night and morning wake time, this diary was provided for each night of the study. The diary includes a place to document additional sleep information, meal/caffeine intake, and other activities for each day. It was utilized while downloading sleep data and when providing feedback to parents. Research has shown that when paired with actigraphy, an accurate picture of sleep duration and quality may be obtained in the home over an extended period of time. (Acebo, et al., 1999; Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991; Wolfson, Hafer, & Carskadon, 1999; Wolfson et al., 2003).

Daily Teacher Questionnaire. A likert-type 4-question scale (1=never, 4=always) measuring observed student attention: alertness, on-task, focus, and concentration. This scale was completed daily by each student's classroom teacher.

Design and Procedure

Flyers offering a free "Sleep Check-up" were disseminated among children in second grade within a local school system. Contact information was provided on the flyer for those parents interested in learning more about participating.

Upon responding, interested parents were informed that the "Sleep Check-Up" was offered as part of a dissertation research study. In addition, parents were informed that their child's participation and results of the "sleep check-up" would be strictly confidential, that no individual child or family would ever be identified. A detailed description of the study including the length of the study (four weeks), use of actigraphy monitoring, a daily sleep diary, and daily teacher rating scales was provided. The parents were also informed that at some point during the study, they would be provided a power-point presentation on sleep in school-age children. Parent questions were solicited.

If interested in participating, parents completed a short questionnaire by phone about their family demographics and their child's sleep. The questionnaire was developed from the BEARS brief screening instrument designed for pediatricians to interview parents and children (ages 2-18) as part of taking a sleep history. Questions asked fell into the five BEARS domains: Bedtime Problems, Excessive Daytime Sleepiness, Awakenings During the Night, Regularity of Sleep/Wake Periods, and Average Length of Sleep (Owens & Dalzell, 2005). Students chosen to participate had the highest degree of sleep difficulties as reported by parents on the initial questionnaire.

Three hundred ninety flyers were sent home with 2nd grade students. Eight families responded with a phone call for a response rate of 2.6%. Seven families completed the initial questionnaire.

Chosen participants were contacted by phone. Confidentiality was reviewed again as well as requirements for participation. If still interested in participating in the study, parents agreed to allow their child to wear the actigraph watch for 4 weeks, keep a daily sleep diary for each day of the study, agreed to a one-hour educational PowerPoint presentation on sleep, and gave permission for their child's teacher to complete a daily behavior scale for the duration of the study. After the parents and children gave consent, teachers were contacted with regard to completing daily behavior scales.

On the day that data collection began, parents were given the actigraph watch and diary. Instructions for the actigraph (when to put it on and take it off) and diary completion were reviewed, contact information was provided, and meeting times for data download was scheduled as well as times for intermittent phone calls to ensure completion of the daily sleep diary and provide opportunities for parent or student questions.

During each night of the four weeks of data collection, each student wore the actigraphic monitors and parents completed the daily sleep diary. Parents were contacted by phone weekly. The sleep diary and actigraph were dropped off and picked up at an agreed upon time and location after each consecutive 7-day wearing of the actigraph so that data could be downloaded. Teachers were emailed a four-question behavior scale each day.

Students were randomly placed in an order of receiving parent intervention. After one week of baseline, two families were provided the sleep education PowerPoint presentation. After week two, another set of families received the intervention. After week three, the last set of families received the intervention. After the 4th week, actigraphs were collected. One week prior to intervention, the families were notified. Each family was given a choice of attending a one-on-one PowerPoint presentation with the presentation emailed and a hard copy sent home or not attending a one-on-one presentation but receiving the program by email and a hard copy of the presentation. A single subject across multiple baseline experimental design was used.

Actigraphic raw data were downloaded and transformed into the pertinent sleep variables via the Octagonal Motionlogger Interface with ACTme Software, and the

Analysis Software Package (ActionW2, 2002). These sleep/wake measures have been demonstrated to have validity in calculations of sleep parameters, including those for children, when compared with polysomnography (Sadeh, Sharkey & Carskadon, 1994; Sadeh, Acebo, Seifer, Aytur & Carskadon, 1995). Procedures for setting times for sleep onset followed a lab protocol developed at the E.P. Bradley Hospital Sleep Laboratory at Brown University (Acebo & Carskadon, 2001). Movement at a threshold level for a period of time based on the Sadeh scoring algorithm is scored as “awake” or “asleep” (Sadeh et al. 1995; Sadeh et al. 1994). Very good reliability and validity for actigraphic measures have been reported (Acebo, et al. 1999; Sadeh et al. 2002).

Once the information from the actigraph was downloaded and analyzed, parents were provided the results and resources including contact information for local sleep labs.

Data Analysis Plan

Data were analyzed using graphical display and descriptive statistics. For the purpose of this study, five variables measuring sleep were examined: Sleep Minutes (total minutes scored as sleep), Sleep Efficiency (100* Sleep Minutes/O-O Duration), Sleep Duration (Minutes from start to end of interval), Wake after Sleep Onset (Wake minutes during the O-O interval), and Activity Index (% epochs with >0 activity score). A behavioral measure calculated using daily scores from teacher completed behavior scales was examined as well.

Total group and individually generated actigraphy and behavioral data were first examined to provide overall normative values for the 28-consecutive days of data collection. Variable values were then broken down for pre and post-intervention comparisons. Individual subject data were further examined for weekly average comparisons and determining each subject's frequency of meeting or exceeding baseline mean variable values post-intervention.

RESULTS

Group values will first be presented followed by individual subject data. Individual subject data will be supplemented with information from parent-completed daily sleep diaries. Efficacy of intervention will be determined by post-intervention increase in mean values measuring sleep minutes, sleep efficiency, and sleep interval duration; decreased values measuring wake minutes after sleep onset and activity index. Improvement will also be indicated when the frequency of meeting or exceeding baseline mean values increase post-intervention. For the purpose of this study, long-term variable improvement for each subject will be proposed when variable improvement is shown both when comparing post-intervention and baseline period and when comparing the last week of data collection to that of the baseline period.

Overall Group Values

Table 1 shows that for this 28-day study, group values included 157 measures generated for 4 of the 5 sleep variables: Sleep Minutes, Sleep Efficiency, Sleep Duration, and Wake After Sleep Onset. There were 156 measures for the Activity Index variable (one measure was lost during data download). Subject 1 wore the actigraph 25 of the 28 days; Subject 2 , 27 of the 28 days; Subject 3, 27 of the 28 days; Subject 4, 25 of the 28 days; Subject 5, all 28 days; and Subject 6, 25 of the 28 days. Reasons for not wearing the actigraph included forgetting to put the watch on or spending the night away from home.

Over the course of the study, the group (N=6) averaged 459.968 (SD 60.331) minutes of sleep per night (7 hrs, 40 min). The minimum minutes of sleep at night was recorded as 255 minutes (4 hrs, 15 min) while the maximum was recorded as 593 minutes (9 hrs, 53 min) producing a range of 338 minutes (5 hrs, 38 min). The average group efficiency value was 88.20% (SD 6.88). The minimum efficiency value was 63.39%; the maximum value was 99.58%. The average duration of sleep (time in bed) was 523.89 minutes (SD 60.099; 8 hrs, 44 min). The range of values for duration was 397 minutes with a minimum value of 348 (5 hrs, 48 min) minutes and a maximum value of 745 minutes (12 hrs, 25 min). For the group, wake after sleep onset averaged 61.68 minutes (SD 36.80) for the 4-week study. The lowest value for wake after sleep onset was recorded as 2 minutes, while the highest was 217 minutes. Lastly, the average activity index for the duration of the study was 41.87% (SD 9.642) with a range of 21.06% to 67.94%.

Teacher-completed behavior scales were completed for 5 of the 6 subjects. The classroom teacher for Subject 6 did not participate. The teachers generated a total of 69 measures. Of the possible 20 measures for each subject, subject 1 had ten; subject 2 had seventeen measures; subject 3 had sixteen; subject 4 had fourteen; and subject 5 had seventeen of the possible 20 measures. Reasons for not completing a daily behavior scale included the teacher forgetting or absenteeism. The average rating of student attention was 11.23 (of 16) with a standard deviation of 2.58. Scores ranged from 6-16 points.

Group Baseline and Post-Intervention Values

Table 2 shows that for the group, mean minutes of sleep during baseline was 459.05 minutes. The post intervention average was 460.85. This shows an increase of 1.80 minutes. The minimum value for sleep minutes increased from 255 minutes during baseline to 270 minutes after intervention. The group's mean sleep efficiency score was 87.44% during baseline. The post intervention mean for sleep efficiency was 88.93%. Both minimum and maximum values for sleep efficiency increased after intervention (63.39% to 72.05% and 98.59 to 99.58%). Duration of sleep intervals during baseline averaged 526.623 minutes while post-intervention measures averaged 521.26 minutes although the maximum measure for duration increased from 666 minutes during baseline to 745 minutes post-intervention.

The group averaged 65.14 minutes of wake time after sleep onset during the baseline period. Averaging 58.34 minutes post-intervention, the group as a whole improved by 6.81 minutes. Both minimum and maximum measures for wake after sleep onset decreased post-intervention (from 7 to 2 minutes and from 217 to 173 minutes). Lastly, the average activity index during baseline for the group was 41.20%; the average following intervention was 42.50%. For this variable, both minimum and maximum values increased following intervention. Group mean values showed that sleep minutes, sleep efficiency, and wake minutes after sleep onset variables improved following intervention.

Baseline behavior ratings during the 28-day period averaged 11.23 of the possible 16 points. The scores ranged from 7 points to 16 points. The baseline mean averaged 11.43 points. The post-intervention mean of 11.26 showed no improvement for the group as a whole. The minimum value of 7 decreased to 6 during the post-intervention period increasing the range from 9 to 10 points.

The daily sleep diary completed by parents produced additional information about the characteristics of those subjects who participated in the study. Of the 6 subjects, five developed an illness at some point during the study. For 4 of those subjects, average length of illness was 4.5 days for the 28-day study and included illnesses identified as an ear infection or cold/allergy. The fifth subject was documented with symptoms of illness and medication intake for 21 of the 28 days of data collection. Medications included Ibuprofen, Amoxicillin, Dimetapp, or Albuteral and included two 7-day rounds of Amoxicillin. The first round of antibiotics was prescribed for strep throat. The second round was prescribed for a chest cold.

The average time to bed reported by parents for the 28 days of data collection was 9:21pm. The average time to sleep as measured by actigraphy was 9:50pm. Sleep diary documentation found that following intervention, 4 of the 6 subjects averaged earlier bedtimes. Actigraphy measures for these four subjects support these parent reports.

The daily sleep diary also provided information to determine percentages of days of caffeine consumption and participation in specific activities within the hour before bedtime. Four of the six 2nd grade subjects were reported as having consumed caffeinated drinks during the course of the study. Percentage of days with caffeine consumption per subject ranged from 15% to 81%. Percentages of days participating in specific activities within the hour of bedtime found that the participants, on average, watched television in the hour before bed 63% of the days, took a bath or shower 56% of the days, read before bed 52% of the days, ate a snack or dinner in the hour before bed 25% of the days, and played with toys or games 25% of the days reported.

Individual Subject Values

Tables 3-8 provide descriptive statistics calculated for each subject's sleep and behavioral measures generated over the 28-day period of data collection. Tables 9-14 show descriptive statistics for each subject's variable measures pre and post-intervention. Table 15 shows weekly means for each subject on the 5 sleep measures. Table 16 shows a summary of sleep variable improvement for all subjects. Tables 17-22 show percentage of days meeting baseline mean per variable for each subject. The percentage of days meeting or exceeding baseline mean during the intervention period will be presented when the sleep variable showed improvement post-intervention or when no improvement was found but an increase of frequency is found post-intervention. Table 23 provides a summary of each subject's improvement with regard to percentage of days meeting or exceeding baseline mean value post-intervention for each variable. Table 24 shows a summary of the behavior ratings and each subject's improvement. Appendix H provides graphical displays of each student's nightly measured sleep minutes for the 28 days of data collection.

Subject 1. Subject 1, a male, while having no formal diagnosis of ADD/ADHD, is prescribed 18mg of Concerta each day. He averaged 483.44 (SD 43.640) minutes of sleep during the 28-day study (See Table 3). Table 9 shows that baseline average (6 days) for sleep minutes was 454.5. Post-intervention (19 days) average was 492.58. This shows an increase of 38.08 minutes following intervention. Both minimum and maximum values for sleep minutes increased (345 to 428 and 515 to 550). As Table 17 shows, subject 1 met or exceeded baseline mean for sleep minutes 16 of 19 nights (89%) compared to baseline period (67%). Efficiency mean for the month was 88.28%. Pre and post-intervention measures show an improvement for his mean efficiency value. Mean efficiency increased from 82.05% during baseline to 90.25% post intervention. Both minimum and maximum values for sleep efficiency increased following the intervention (63.39% to 79.83% and 91.09% to 95.17%). In addition, the efficiency mean met or exceeded baseline mean 89% of the days versus 67% during the baseline period Table 17).

Subject 1 had an overall four-week average of 550.16 minutes for duration of sleep. Baseline mean for duration decreased from 557.5 minutes during baseline to 547.84 following intervention. Noteworthy is that while the minimum value for duration did not increase, the maximum value increased from 575 minutes to 626 minutes. Measures for minutes awake after sleep onset and activity index improved post intervention for this subject. The subject's overall mean value for awake after sleep onset for the 4-week period was 65.72 minutes. During baseline the mean value was 101.67 minutes. Post-baseline average was 54.37 minutes. Post-intervention measures show that the subject met or exceeded the baseline average 89% of the days versus 67% during baseline. Awake minutes decreased from 50 minutes as minimum value to 24 minutes post intervention. The maximum value of 119 decreased to 58.22 after intervention. Activity index averaged 44.30% for the month. This value decreased from a mean of 53.07% during baseline to a mean of 41.54% post intervention. The percentage of meeting/exceeding baseline measures increased from 50% during baseline to 89% of the days post-intervention.

Referring to Table 15, long-term improvement was indicated for variables measuring sleep minutes, sleep efficiency, wake after sleep onset, and activity index. Values for these variables consistently showed improvement during post-intervention as compared to baseline, 4th week compared to week 1 of data collection, and last week vs. baseline.

Subject 1 averaged a daily behavior rating of 12.0 of 16 points during data collection, baseline, and post-intervention periods. However, average measures increased during the last week as compared to the first week of data. In addition, the scores during the last week averaged higher than the baseline mean (Table 24).

The sleep diary provided additional information on life-style and activities for Subject 1. The overall average time to bed for this subject was 8:57pm during the 4-week study. The average time of sleep onset, according to actigraphic data was 9:31pm. Following the intervention, average time to bed was earlier at 8:49pm versus the 9:15pm average recorded by parents during baseline. Time of sleep onset also changed from 9:45pm to 9:26pm post-intervention.

Subject 1 was one of two subjects who did not drink caffeinated beverages throughout the study. His most common activities before bed were documented as reading 67% of the 28 days, watching television 62% of the days, taking a bath/shower 29% of the days, and playing with toys/games 29% of the days. Additional activities reported accounted for less than 10% of the days (snack 10%, computer 5%).

Subject 2. Subject 2, a female, averaged 385.26 (SD 76.18) minutes of sleep during the 28-day study (Table 4). Baseline average (14 days) for sleep minutes was 384.29 while post intervention was 386.31 minutes. This shows an increase of 2.1

minutes following intervention. When sickness was controlled, an improvement from 384.29 to 403.30 minutes was found. The minimum value for sleep minutes increased while the maximum value decreased (255 min to 270 min and 583 min to 572 min). Subject 2 met or exceeded sleep minutes baseline mean 46% (60% when sick was controlled) of the nights during the post-intervention period as compared to 36% during the baseline period. The average efficiency measure for the length of the study was 79.656%. Mean efficiency decreased from 79.91% during baseline to 79.38% post intervention. Both minimum and maximum values for efficiency decreased following the intervention (72.12 min to 72.05 min and 89.01 min to 85.93min).

Subject 2 averaged 485.52 minutes (91.78 SD) for sleep duration during the 28-days of data collection. She showed an increase in average sleep duration measures following intervention. Baseline mean was 483.86 minutes versus the post intervention mean of 487.31 minutes. When sickness was controlled, the post-intervention mean measure increased to 513.30 minutes. The sleep duration baseline mean was met or exceeded 50% of the days post-intervention as compared to 43% during baseline (Table 18).

The variable measuring minutes awake after sleep onset, while averaging 96.82 minutes for the entire study reflects an increase in an average of measures post-intervention. The subject's mean value for awake after sleep onset during baseline was 92.93 minutes; post-baseline average was 101.00 minutes. Activity index for subject 2 during the study averaged 46.56%. This measure improved with a mean of 45.50% (45.53% when sick controlled) post-intervention as compared to 47.62% during baseline. In addition, the activity index baseline mean was met or exceeded 62% of the post-intervention days (50% when sick days controlled) as compared to 38% established during baseline.

Referring to Tables 15, long-term improvement was noted for variables measuring sleep minutes, sleep efficiency, and activity index. Values for these variables consistently showed improvement post-intervention, 4th week mean compared to week 1 of data collection, and last week mean vs. baseline (minutes only when sickness controlled for last week vs. baseline).

No improvement was found post-intervention (13.2 vs. 11.3) for measures of attention as rated by the classroom teacher (Table 24). However, the last week averaged higher scores than those during the first week of data collection (13 vs. 12.8). When sickness was controlled for, the post-intervention average decreased from 12.0 to 8.5 points and the last week's average decreased from 13.0 to 10.0 points. No pattern of improvement was found when weekly averages were compared. Week 2 improved with an average of 13.6 but then decreased to an average of 10.5 (7.0 when sickness controlled) during the 3rd week and then increased to average 13 points each day during the last week (10.0 when sickness controlled). Interesting is that when sickness was controlled (removed), the average of the ratings decreased suggesting that the student's sickness may have been mistaken for increased attention during those days the parents documented as sick days (days 22-24).

Sleep diary and actigraphic data documented that subject 2 went to bed at an average time of 10:43pm during the 28 days of data collection. Average time of sleep onset was 10:59pm. Time of going to bed showed improvement from 10:46pm during baseline to 10:40pm post-intervention. Time to sleep improved from 11:08pm to 10:50pm following intervention.

According to the sleep diary, this subject drank caffeinated beverages on 6 of 27 days. On four of these days, the drink was after 6 pm; for two of the days, the drink was between noon and 6pm. The most frequently participated activities during the last hour before bed included television watching 75% of the 28 days, book reading 68% of the days, homework 46% and listening to music 46%. Other activities included bath 29%, having a snack 21%, playing with toys/games 14%, and playing video games 3% of the days.

Subject 3. Subject 3, a male, showed improvement on only one variable following intervention. Table 5 shows that the average activity index measure was 29.03% for the month of data collection. The mean activity index value decreased from 29.16% during baseline (20 days), to 28.65% in the post-intervention period (Table 11). In addition, the activity index is the only variable which met or exceeded the baseline mean with 86% of the post-intervention period as compared to 55% of the days during baseline (Table 19).

During the 28-day study, subject 3 averaged 469.48 (SD 26.47) minutes of sleep each night. Baseline average for sleep minutes was 471.6 while post intervention was 463.43 minutes. Efficiency measures decreased as well. Mean efficiency decreased from 88.88 to 88.49% post intervention. Both minimum and maximum values decreased following the intervention (85.92% to 84.20% and 91.67% to 91.44%).

The mean value for sleep duration decreased following intervention (530.70 min to 524.29 min). The minimum value increased from 469 to 478 minutes while the maximum stayed the same (572 minutes). Mean wake minutes after sleep onset was 58.10 minutes during baseline and 60.86 minutes after intervention. Although when comparing weekly averages, his last week's average (60.86 minutes) improved as compared to his first week's average (63 minutes). As noted previously, subject 3 showed improvement in activity index following intervention. This improvement was also shown when the mean of the first week was compared to the last (29.22% to 28.65%) and when the mean of the last week was compared to his baseline mean (29.16% to 28.65%) suggesting long-term improvement in this variable (Table 15).

With regard to the behavior rating scales, scores improved following intervention. The baseline mean shown on Table 24 was 12.55 while the intervention mean was 12.60. Both the post-intervention and last week periods averaged 12.6 versus the first week average of 12.5 and the baseline average of 12.55.

The sleep diary provided additional information on life-style and activities for subject 3. The average time to bed for this subject was 9:24pm. The average time of sleep onset, according to actigraphic generated data was 9:52pm. Post-intervention measures showed an average of 9.26 pm to bed versus an average of 9:23pm during baseline. Time to sleep had a mean value of 9:48pm during baseline and 10:00pm following intervention.

Subject 3 was one of two subjects who did not drink caffeinated beverages throughout the study. His most common activities before bed were documented as taking a bath/shower 100% of the days, reading 64% of the 28 days, playing on the computer 36%, watching television 18% of the days, or having a snack 21% of the days.

Additional activities reported accounted for less than 12% of the days (homework 11%, playing video games 7%, playing with toys/games 4%, and talking on the phone 4%).

Subject 4. Subject 4, a male diagnosed with ADHD is prescribed 54 mg of Concerta each day. This subject was sick during the first 4 days of data collection. Scores will be reported both with data from those days and then with sickness controlled. Like Subject 3, he showed improvement only in his mean measure of activity index post-intervention (only when sickness was controlled). His average activity index measure for the month was 47.09% (Table 6). The mean activity index value decreased from 47.09% (44.66% when sickness controlled) during baseline (18 days) to 44.60% in the post-intervention period (Table 12). In addition, the activity index met or improved from baseline mean 57% of the post-intervention period as compared to 50% of the days during baseline (Table 20).

Subject 4 averaged 467.76 (SD 48.88) minutes of sleep during the 28-day study. Baseline average for sleep minutes was 472.22 (473.93 when sick controlled) while the post intervention mean was 456.29 minutes. Both minimum and maximum values for sleep minutes decreased after baseline (371 to 335 and 574 to 504). While the mean value did not increase post-intervention, the percentage of days he met or exceeded the baseline mean during post-intervention increased slightly from 56% to 57% of the days. Efficiency measures, while averaging 85.62% for the study, showed no improvement when comparing the baseline mean of 85.84% (87.15% when sick controlled) to the post-intervention average of 85.07%. Interesting is that both minimum and maximum values increased post-intervention (65.01 to77.55 and 93.65 to 94.81). The mean value for duration for the 28 days was 550.04 minutes. The baseline mean of 553.83 minutes

(547.14 when sick controlled) decreased to an average of 540.29 minutes post intervention. Again both minimum and maximum values decreased following intervention. While duration did not show an increased average following intervention, his percentage of days for meeting or exceeding baseline mean increased during the post-intervention period when sickness was controlled. He met or exceeded baseline mean 71% of time as compared to 57% met during the baseline period.

The wake after sleep onset variable averaged 78.76 minutes during the 4-week period. He had a mean value of 78.44 minutes of wake after sleep onset (70.50 when sick controlled) during baseline and 79.57 following intervention, although minimum and maximum values both decreased (28 to 25 minutes and 197 to 109 minutes) post-intervention.

While subject 4 showed improvement in only one variable mean (activity) post-intervention, several other variables showed improvement during the last week as compared to the first week of data collection (Table 15). During the last week, sleep efficiency improved to a mean of 85.07% as compared to 82.04% during baseline. Minutes awake after sleep onset decreased to average 79.57 min during the last week of data collection as compared to 101.33 min averaged during the first week.

Table 24 shows that post-intervention measures for attention as rated by the classroom teacher improved. His mean daily score during baseline was 9.50 (9.6 when sickness controlled) as compared to 9.75 post-intervention and for the last week.

The sleep diary provided additional information on life-style and activities for Subject 4. The average time to bed for this subject was 8:31pm. The average time of sleep onset, according to actigraphic-generated data, was 8:52pm for the month.

Following intervention, time to bed, on average, changed from 8:56pm (baseline) to 8:40pm. Time to sleep went from 9:50 to 9:10pm. Subject 4 was reported to have consumed caffeine on 4 of 26 days accounted. On those days, the drinks were consumed between the hours of noon and 6pm. His most common activities before bed were documented as taking a bath/shower 89% of reported days, watching T.V. 67%, reading 59% of days, having a snack 41% of the days, and playing with toys/games 26% of the days. Additional activities reported took place less than 10% of the days (computer 4%, exercise 7%, talked on telephone 4%, played video games 4%).

Subject 5. Subject 5, a female, did not initially show improvement on any of the five sleep measures post-intervention. Only when sickness was controlled (days 25-28) was improvement found. With sickness controlled, Subject 5 showed improvement in two measures for sleep quantity and quality. Sleep efficiency, while averaging 95.85% for the month (Table 7), improved from 96.47% during baseline (14 days), to 95.23 (96.71% when sick controlled) post-intervention (Table 13). She met or exceeded the baseline mean 60% of post-intervention days versus 43% during baseline (Table 21).

This subject averaged 21.04 minutes of wake after sleep onset during the 28-day period. The baseline mean value was 17.86 minutes and the post-intervention mean was 24.21 minutes (17.30 minutes when sickness was controlled). She met or exceeded the baseline mean value 50% of the days during the post-intervention period as compared to 43% during baseline when sickness was controlled.

Long-term improvement was indicated for both sleep efficiency and minutes measured as awake after sleep onset. When comparing the last week average (efficiency, 97.87%; awake time 16.67 minutes) to the first week (97.19%; 35.45 minutes) and the baseline mean (96.47%; 17.85 minutes), the agreement between post-intervention improvement and 4th week vs. baseline mean improvement indicate long-term improvement (Table 15).

Sleep minutes, sleep duration, and the activity index sleep variables did not show improvement following baseline in terms of mean values or the consistency in meeting or exceeding the mean values (Table 21). Subject 5 averaged 465.14 minutes of sleep each night during the study. The baseline average for sleep minutes was 485.64 while post intervention was 444.64 minutes (445.10 when sick controlled). Both the minimum and maximum values measuring sleep minutes decreased post-intervention (438 to 330 minutes and 526 to 512 minutes). The mean value for sleep duration was 487.36 minutes for the study. Baseline average fell from 504.14 minutes during baseline to 470.57 minutes (464.10 when sick controlled) post-intervention. Again both minimum and maximum values for duration decreased following the intervention (445 to 348 minutes and 557 to 532 minutes). The variable measuring activity index showed no improvement as a result of intervention. The subject's mean value for activity index for the 4-week period was 38.319%. The average baseline measure was 37.64% and the period following intervention averaged 38.03% (39.0% when sick was controlled).

Table 24 shows that no improvement was found on behavior measures post-intervention. Subject 5 averaged 10.2 of the 16 possible points during baseline and 9.85 (9.0 when sickness controlled) during the post-intervention period. The average behavior score during the last week was 10.6 (10.0 when sickness held). Like Subjects 2 and 4, when sickness was controlled, behavior scores actually decreased (intervention average fell from 9.85 to 9.0 and the last week's average fell from 10.6 to 10.0.

Sleep diary and actigraphic data documented that Subject 5 went to bed at an average time of 10:17pm during the 28 days of data collection. Average time to sleep was 10:54pm. An examination of bedtimes showed improvement to 10:02pm from 10:32pm. Time to sleep also improved from 10:40 during baseline to 10:23pm following intervention. This subject drank caffeinated beverages on 12 of 27 days. On 5 occasions, caffeine was consumed before noon. On four occasions, consumption took place between noon and 6pm. On six occasions, the child drank caffeinated drinks after 6pm. This subject participated in the following activities within the hour of bedtime: television watching 58% of the 28 days, bath/shower 31% of the days, book reading 27% of the days, homework 23%, and playing with toys/games 19% of the days. Other activities included snack 11%, computer 4%, and talking on the phone 4% of the days.

Subject 6. Subject 6, a female, averaged 493.32 (SD 42.23) minutes of sleep during the 28-day study (Table 8). Baseline average (6 days) for sleep minutes was 501.8 while post-intervention was 491.20 minutes (Table 14). The minimum and maximum values for sleep minutes decreased following intervention (458 to 391 minutes and 593 to 563 minutes). Efficiency measures averaged 90.78% for the duration of the study. An increase in mean values was found when comparing the baseline mean of 89.77% to the post-intervention mean of 90.98%. Frequency of meeting or exceeding the baseline mean increased from 20% during baseline to 70% post-intervention (71% when sick was controlled).

The average minutes of sleep duration during the study was 548.28 minutes. There was a decrease in mean minutes of sleep duration following intervention (558 to 45.85 minutes) even though the maximum measure increased from 627 to 646 minutes.

The mean value of the variable measuring minutes of wake time after sleep onset improved post-intervention. The month of measures averaged 51.20 minutes. The mean value for this measure decreased from 56.2 minutes during baseline to 49.95 during the post-intervention period. The percentage of meeting or exceeding baseline mean during the intervention period increased from 60% minutes during baseline to 70% during the post-intervention period.

When sickness was controlled, activity index improved with a mean of 48.04 (46.26% when sick controlled) from the 47.17% average during baseline. Long-term improvement was noted for variables measuring sleep efficiency, wake minutes after sleep onset, and activity (when sick was controlled). Values for these variables consistently showed improvement when comparing post-intervention to baseline (Table 22), baseline to 4th week of data collection, and 1st week to the 4th week of data collection (Table 15).

Sleep diary and actigraphic data documented that subject 6 went to bed at an average time of 8:27pm during the 28 days of data collection. Average time to sleep was 8:49pm. An examination of bedtimes pre and post-intervention shows that on average, the subject went to bed at 8:20pm during baseline and 8:30pm following intervention. In addition, actigraphic data showed that the average time to sleep during baseline was 8:30pm and was 8:58pm following intervention.

This subject drank caffeinated beverages regularly during the 28-day study (81% of days). She was documented as having drank caffeine equally between the 3 time periods: before noon, noon to 6pm, and after 6pm. For subject 6, the most frequently participated activities during the last hour before bed included television watching 100%

of the days, bath 68% of the days, homework 64% of the days, playing with toys/games 48% of the days, having a snack 32% of the days, and reading 28% of the days. Additional activities included listening to music 16% of the days, exercise 12%, playing on the computer 8%, and talking on the phone 4% of the days.

DISCUSSION

Sleep Variable Change

Referring to Table 15, results show that if a variable mean value improved post-intervention, it also showed improvement when comparing the last week and first week of data collection and when last week and baseline means were compared. In addition, variable value improvement for each subject post-intervention predicted an increase in frequency of meeting/exceeding baseline mean values post-intervention (Tables 17-23).

Four variables improved for Subject 1 (minutes, efficiency, wake time after sleep onset, and activity) and Subject 4 (activity, minutes, efficiency, and duration). While Subject 4 saw mean improvement in only one variable (activity) post-intervention, this subject showed increased frequency during the post-intervention period in meeting/exceeding the baseline mean values for sleep minutes and duration of sleep intervals. This subject also showed improvement in measured efficiency during the last week as compared to the first week of data collection. Three variables showed improvement for Subjects 2 (minutes, duration, activity) and 6 (efficiency, wake time after sleep onset, activity). Two variable values improved for Subject 5 (efficiency, wake time after sleep onset) and Subject 3 (activity and wake time after sleep onset). For Subject 3, improvement for wake after sleep onset was found only when comparing the last week of data collection to the first week.

Referring to Table 23, activity index was the most common sleep variable to show improvement post-intervention (5 of 6 subjects). Variables measuring sleep efficiency, wake time after sleep onset, and sleep minutes improved for 3 of the 6 subjects. Sleep duration was shown to be the variable least likely to improve (increase) following intervention (1 of 6 subjects). This is interesting because as noted in the results, daily sleep diary documentation and supporting actigraphy data showed that following intervention, 4 of the 6 subjects averaged earlier bedtimes. This could indicate that sleep duration may be more reflective of a biological rhythm which is resistant to short-term changes and as a result, takes a longer period of time to reset.

Table 15 shows that while 5 of the 6 subjects showed immediate variable value improvement during the week following baseline (one showed improvement on 5/5 variables, one showed improvement for 4/5 variables, and 3 showed improvement on 1/5 variables) this was only a 40% success-rate (12/30 possible improved values). The average number of sleep variable values to increase per subject was 2. The second week after intervention showed a higher improvement rate with a percentage of 65% (13 of 20 possible values improved). The average number of improved variable values was 3.2. This may be one of the reasons that Subjects 3 and 4 were shown to have the fewest number of variables showing mean value improvement post-intervention (1 of 5 variables). It could also explain why Subject 4 was the only subject to show improved frequencies for variable values post-intervention that were not also identified as variables having shown improvement post-intervention. For these subjects, intervention took place after the third week of data collection, leaving only seven days to show improvement post-intervention. For these two subjects, the activity index variable value was the only variable to show improvement post-intervention although both subjects showed additional variable improvement when comparing first week and last week of data collection. Subject 3 showed improvement on two of the five variables while Subject 4 showed improvement on three of five variables. Both showed improvement on the wake minutes after sleep onset and activity index variables when comparing first and last week mean values.

Long-term improvement, based on agreement between period improvement (post-intervention versus baseline mean; last week versus baseline mean), was found for all six subjects (Table16). Subject 1 showed long-term improvement on four of five sleep variables including sleep minutes, efficiency, wake time after sleep onset, and activity. Subject 2 had long-term improvement for three of five variables including minutes, duration, and activity. Subjects 3 and 4, showed long-term improvement on one variable (activity). Subject 5 evidenced long-term improvement for two of the five sleep variables including sleep efficiency and wake time after sleep onset. Subject 6 showed long-term improvement for three of five variables including efficiency, wake time after sleep onset, and activity.

Long-term improvement was most often seen with activity measures (5/6 subjects). Efficiency and wake after sleep onset showed long-term improvement with three of six subjects. Minutes of sleep showed long-term improvement for two subjects; duration showed long-term improvement for only one subject. Important to note here is that Subjects 3 and 4, who had the least number of long-term sleep variable improvement, also share the same classroom and teacher. Could their daily environment or experience have been stronger than parental influence on sleep values?

Behavior Change

Table 24 shows post-intervention improvement on behavioral measures. Post-intervention improvement occurred for two of five subjects. Two additional subjects showed improvement when comparing the first and last week of data collection. For one of those subjects, the last week's mean value was improved over the baseline mean value as well. Due to disagreement in period improvement, only two subjects were shown to have long-term behavior variable improvement. In addition, these two subjects, Subjects 3 & 4, were found to be the only subjects whose frequency of meeting or exceeding baseline mean values for behavior increased post-intervention.

An examination of behavior and sleep variable improvement did not find a relationship between improved sleep and behavior variables. With regard to sleep variable improvement, Subjects 3 and 4 showed long-term improvement on only activity measures. Three additional subjects showed long-term improvement for activity measures, yet they did not show post-intervention or long-term improvement for behavior variable mean values. As noted in the results, when sickness was controlled, two subjects' behavior scores actually decreased (measures of attention were rated higher on days these kids were reported sick and taking medication) suggesting that student activity level may influence teacher ratings of observed behaviors of attention.

Comparison Between Boys and Girls

A comparison of data between boys (N=3) and girls (N=3) found that over the course of this study, boys averaged 473. 45 minutes of sleep each night compared to girls who averaged 446.98 minutes (Table 25). Girls showed higher average efficiency measures (88.79%) compared to boys (87.59%). Boys showed longer average duration values (542.71 minutes) compared to the girls (505.78 minutes). Boys showed more wake after sleep onset time (67.53 minute average) versus the girls who averaged 56.04 minutes. Lastly, boys showed a lower activity index average (39.63%) compared to the girls (44.05%). Thus, while boys generated higher average measures for sleep minutes and duration measures, they were more active, spent more time awake after sleep onset, and had less degree of sleep efficiency. Similar results were generated when Buckhalt, El-Sheikh, and Keller (2007), studying sleep and cognitive functioning with a sample of eight-year olds, found that girls had lower sleep activity, better sleep efficiency, and longer sleep duration than boys.

With regard to intervention, short-term improvement looked only slightly different than long-term improvement for boys. Girls showed no difference between short and long-term improvement. While not showing a difference between boys and girls when comparing sleep minute variable improvement long-term, boys showed more short-term improvement (2 versus 1). Data indicated long-term improvement twice as often for girls on sleep variables measuring duration, efficiency, and wake time after sleep onset. Activity index improved for all three boys while improving for only two girls. Duration variable values did not show short or long-term improvement for boys. One female showed both short and long-term improvement in this sleep variable. Thus, while boys more often showed short-term improvement for sleep minutes, girls were found to more often improve sleep efficiency, duration, and wake after sleep onset variables as compared to the boys. Two of the three boys were found to have improved behavioral variables both short and long-term while none of the girls showed improved behavior measures.

Pharmacological Effects

Prescription medication for ADHD did not appear to decrease a subject's improvement in any sleep variable measure as compared to those who did not take daily medication for ADHD symptoms. Both Subject 1 and Subject 4 took prescription Concerta each day. While Subject 1 took only 18 mg and showed long-term improvement on 4 of 5 sleep variable measures, behavioral measures did not improve. In addition, this subject took several other medications throughout the month of data collection. Because illness and medication intake occurred so frequently during this study, sickness could not be controlled for Subject 1. Subject 4, the only subject to have a clinical diagnosis of ADHD and take 54 mg of Concerta each day, showed improvement on several variables. Like other subjects, immediate change was not evident in all these variables following intervention. It must be noted that this study could not rule out pharmacological effects, which could have decreased his ability to show immediate change. However, Subject 4 is one of two subjects who showed both short and long-term improvement on the behavioral measure.

Limitations

Potential limitations of this study include the generalizability to students outside of Grade 2. Normative values for objective measures of sleep for typically developing children are sparse and therefore the values and response to intervention found in this study could be a local or regional phenomena. In addition to the normative values generated, characteristics of children in grade 2 may be different than children in other grades. For instance, children in grade 2 may be more compliant with changes in routine or may adapt to changes more easily.

Other limitations to be considered include the sample size and effects of convenience sampling. The reliability of results from this study are limited. A stronger case could be made with a sample size larger than six students. In addition to the size of the sample, convenience sampling could have influenced the low response rate. Due to such a low response rate, this study had to use those who responded regardless of the degree of sleep problems reported by the parents. One of the consequences of this could be that some children did not show particularly poor sleep variable measures during baseline and because of this, there may have been a ceiling effect such that there was little room for improvement.

Of those parents who did respond, the limitations of self-selection bias and parent compliance should be considered. With a 2.6% response rate, these parents may be quite different than those in the rest of the population. The parents who responded to the invitation to participate in this study may be more likely to read, participate, and comply with programs and information developed for the benefit of their child. Other personal characteristics such as strong personal beliefs about sleep practices could affect experimental outcomes as well. For instance, a parent for one subject was adamant in her belief that children should not have set bedtimes, but be allowed to sleep whenever they wished. This subject was the only student whose sleep diary documents "naps" before going to school in the mornings.

Another limitation to be considered is the length of the study. This study may not have been long enough to see change in certain variables. On the other hand, wearing the watch for 28 days could have motivated the parents to be more consistent in behaviors and practices associated with their child's sleep since the actigraphic monitor (watch) had to be placed on the children each night before going to bed.

Other limitations include the possible comorbidity of undiagnosed disorders. As mentioned in the literature review, the development, regulation, and timing of sleep can be altered by behavioral/emotional disorders. Lastly, subjective teacher rating scales tend have low reliabilities and therefore need to be taken in consideration when examining the behavioral data.

Conclusions

Results show that the six children in this sample did not sleep the recommended 10.5 hours of sleep each night, even after intervention. Only three of the six subjects had healthy sleep when measured as obtaining a recommended 90% sleep efficiency rate. Subjects in this current 28-day study averaged a duration of 8:43 (hr:min)(SD=60.10), an activity index measure of 41.87 (SD=9.64), and an efficiency measure of 88.20 (SD = 6.88). Buckhalt, El-Sheikh, and Keller (2007) found that students identified as European-American (N=92) averaged a sleep duration measure of 8:41 (SD=35 min), an activity index of 46.44 (SD=12.23), and a sleep efficiency measure of 86.82 (SD=7.03) while African-American subjects (N=42) averaged a duration measure of 8:19 (SD=35), an activity index of 40.48, and an efficiency measure of 87.34 (SD=7.93). These were significant differences ($p<.01$) between races for sleep measures of activity and duration.

It was hypothesized that parent behavior regarding sleep practices could positively influence child sleep measures. This studied showed that one specific practice, time putting children down, averaged earlier times post-intervention for 4 of the six subjects. Yet duration values improved for only one of those four subjects. As discussed earlier, duration may be a sleep variable that takes longer to show improvement. Noteworthy is that of those children who showed an increase in sleep minutes following baseline, only two showed an increase in both minutes and duration. This indicates that duration may predict minutes, but minutes did not predict duration. Buckhalt, El-Sheikh, and Keller (2007) found only modest associations between measures of sleep quality (activity and efficiency) and sleep quantity (duration).

The four subjects who averaged earlier bedtimes post intervention (Subjects 1, 2, 4, and 5) showed higher levels of sleep variable improvement. These four subjects showed an improvement in 10 out of 20 possible sleep variables versus 4 of 10 possible variables found for the remaining subjects who were not shown to average earlier bedtimes post-intervention. This suggests that while earlier bedtimes did not improve mean sleep duration measures, earlier mean bedtimes appear to have increased a child's chances of improving other sleep variable measures.

The overall efficacy of the experimental effects of the parent education program for this study is difficult to determine. While some variable values improved for subjects, not all variables were found to improve. The limitations previously mentioned may account for this and/or the intervention may not have been strong enough to influence parent behavior. This can be illustrated by the choice of intervention methods that all parents chose. This study provided parents a choice between a one-on-one PowerPoint presentation with a copy (including notes) sent home (via email or hard copy), or only the emailed program/hard copy of the presentation (notes included). All parents chose the method that did not require a one-on-one power point presentation. While results showed positive change in some variables for all subjects, it is hypothesized that more improvement would have been shown had parents had both the one-on-one PowerPoint presentation and a hard copy of the presentation to take home.

Still, results from this study indicate that schools may be able to expect improved sleep values in students just by sending sleep information home. While a passive approach to educating parents, this method may prove less intrusive, more convenient (no attendance, no scheduled times), as well as more cost effective and attractive to parents. School systems may not have access to a speaker and may want to know the effectiveness of just sending sleep information home. This study provides evidence of what schools could expect as long as potential limitations are considered.

In addition, while experimental efficacy of this study is difficult to determine using graphical display and descriptive statistics, there is significant value in the normative data generated with regard to sleep and individual subject practices and characteristics. This is the first experimental sleep study to obtain objective measures of sleep beyond a two week period for typical, normally developing school-age children. This study provides 28-consecutive days of data collection for six children including objective sleep measures as well as parent-completed sleep diary information and teacher completed daily behavior ratings for observed student attention. The collaborative use of data from these tools provided insight to sleep variable values as well as a possible relationship between earlier average time to bed post-intervention and an increase of sleep variable improvement.

From the 28-consecutive days of data collection, normative measures were generated for several sleep variables. With such a long period of data collection, several different comparisons could be made. One benefit of such an extended set of collected data can be illustrated with the variable measuring sleep minutes. It was found that weekly mean values showed that all subjects stayed within 60 minutes of their previous and future week's mean values for sleep minutes (Table 15). Yet, the range in values were much greater when examining day by day values (see Appendix H). So, while great variations in sleep measures occurred for individuals and appear to indicate unstable sleep patterns, these large variations disappeared when measures were averaged across time, revealing a more stable picture of sleep variable patterns.

Implications for Future Research

One challenge for future sleep research includes establishing normative values for objective sleep variables. This study provides 28 consecutive days of normative sleep values. It would be interesting to know how these children compare to their peer group in different regions of the United States and other countries. Would objective measures such as what has been provided through this study change the daily recommended amount of sleep or efficiency rate?

Future sleep research should identify sleep variable relationships. For instance, in this study activity levels decreased, yet wake time after sleep onset and sleep efficiency measures did not show improvement. What accounts for the inconsistency in these values? An additional goal for future research would be to identify if a hierarchy of sleep variable change exists. For example, which if any sleep variable measure has to improve before sleep duration will show improvement? Lastly, future studies should identify objective sleep variables found most to correlate to positive change in academic functioning. Doing so could help establish more concise interventions and measures of experimental effectiveness for parent education programs. This type of research should include objective behavioral measures such as systematic observations to examine behavior variables.

With regard to future parent education intervention studies for sleep, it would prove valuable to follow up with post-study surveys on parent behavioral practices which could account for change found in measures. Such surveys could also identify what information parents find to be most influential on their behavioral practices.

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APPENDIX A: AUBURN UNIVERSITY INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL

Auburn University

Auburn University, Alabama 36849

Office of Human Subjects Research
307 Samford Hall
hsubjec@auburn.edu

Telephone: 334-844-5966
Fax: 334-844-4391

September 5, 2006

MEMORANDUM TO: Ms. Donna Lee
Counseling

PROTOCOL TITLE: "A Parent Education Program to Influence Behavior and Academic Performance by Improving Children's Sleep Quality"

IRB AUTHORIZATION: #06-008 MR 0602
APPROVAL DATE: February 13, 2006
EXPIRATION DATE: February 12, 2007

The referenced protocol was approved "Minimum Risk" at the IRB Meeting on February 13, 2006, pending revisions. (Your final revisions were received on August 24 and approved by the IRB on August 31st, 2006.) Please reference the IRB authorization number in any correspondence regarding your project.

Please remember that any anticipated change in the approved procedures must be submitted to and approved by the IRB prior to implementation of the planned activity. Any unanticipated problems involving risk to subjects or others requires immediate suspension of the activity and an immediate written report of the occurrence to the IRB.

If you will be unable to file a Final Report on your project before February 12, 2007, you must submit a request for an extension of approval to the IRB no later than January 29, 2007. If your IRB authorization expires and/or you have not received written notice that a request for an extension has been approved prior to February 12, 2007, you must suspend the project immediately and contact the Office of Human Subjects Research.

<u>A Final Report will be required to close your IRB project file.</u> Finally, you are reminded that consent forms must be retained at least three years after completion of your study.

If you have any questions concerning IRB procedures or this Board action, please contact the OHSR at 844-5966.

Sincerely,

Peter W. Grandjean, Chair
Institutional Review Board for the Use of
Human Subjects in Research

cc: Dr. Holly Stadler
Dr. Joseph Buckhalt

APPENDIX B: SCHOOL PERMISSION FORMS

Debbie W. Smith
Principal

Deborah A. Brooks
Assistant Principal

Cary Woods Elementary School

To: Human Subjects Research Committee
Auburn University

From: Debbie Smith

Re: Research Activity

Date: 8-22-06

As requested, this letter is written to confirm that Donna Golden Lee has permission to conduct her dissertation research at CWE.

Cary Woods Elementary School
Principal – Debbie Smith
715 Sanders Street
Auburn, Al. 36830

Respectfully submitted,

Debbie Smith
Principal

715 Sanders Street
Auburn, AL 36830

Auburn City Schools

Phone: (334) 887-4940
Fax: (334) 887-4172

DEAN ROAD ELEMENTARY SCHOOL

335 South Dean Road
Auburn, Alabama 36830
(334) 887-4900
Jackie Greenwood, Principal
Shannon Pignato, Assistant Principal

To: Human Subjects Research Committee
Auburn University

From: Jackie Greenwood

Re: Research Activity

Date: October 1, 2006

As requested, this letter is written to confirm that Donna Golden Lee has permission to conduct her dissertation research at Dean Road Elementary School.

Thank you,

Jackie Greenwood
Principal

Lynda Tremaine
Principal

WRIGHTS MILL ROAD
WMR
ELEMENTARY SCHOOL
AUBURN, ALABAMA

Craig Ross
Assistant Principal

807 Wrights Mill Road
Auburn, Alabama 36830
(334) 887-1990 Fax: (334) 887-4180

September 13, 2006

Dear Ms. Lee,

Wrights Mill Road Elementary School will be happy to assist in your dissertation research. Since this will involve second graders, I have asked the second grade teachers to meet with you during their planning time (10:30 a.m.) on September 27th. During that meeting, you can explain what your study involves and can share the letters that the students will be asked to give to their parents.

We look forward to seeing you on the 27th.

Sincerely,

Lynda Tremaine

Lynda V. Tremaine, Principal

Yarbrough Elementary
1555 N. Donahue Dr.
Auburn, AL. 36830
887-1970

To: Human Subjects Research Committee
Auburn University

From: Pete Forster, Principal, Yarbrough Elementary

Re: Research Activity

Date: August 21, 2006

As requested, this letter is written to confirm that Donna Golden Lee has permission to collect data for her dissertation research at Yarbrough Elementary School.

Sincerely,

Pete Forster
Principal, Yarbrough Elementary

APPENDIX C: INFORMED CONSENT FORM

Auburn University
Auburn University, Alabama 36849-5222

Counselor Education, Counseling Psychology
And School Psychology
2084 Haley Center

Telephone: (334) 844-5160
FAX: (334) 844-2860

INFORMED CONSENT FORM
for a research study entitled:

A Parent Education Program to Influence Behavior and Academic Performance by Improving Children's Sleep Quality

Investigator: Donna G. Lee, Ed.S

You are invited to participate in a research study to examine a parent education program to influence behavior and academic performance by improving children's sleep quality. This study is being conducted by Donna Lee, Ed.S, under the supervision of Joseph Buckhalt, Ph.D. We are inviting children in second grade to participate in this study because the examination of how sleep impacts the cognitive and academic performance of children is important to both school psychologists and school personnel. Results may be used for publication or presentation, but individuals will not be identified.

If you decide to allow your child to participate in this study, you may be asked to complete a sleep diary each day for one month (approximately 10-minutes each day), provide consent for your child to wear a sleep watch at night for the duration of the study (4 weeks), attend a 1-hour power point presentation on sleep, and provide consent for your child's teacher to complete a daily 5-question behavior scale.

All information will be strictly confidential, to the extent allowed by the law. No individual child or family will ever be identified publicly. Names are removed from all information gathered on your child and replaced with identification numbers. The information obtained from this study will be kept in a locked file storage area and will not be released to your child's school or to any other person in a way that would reveal the identity of your child. The link between your child's name and his/her identification number will be kept in a separate location from the actual data. This link will be destroyed within two years of data collection, as is routinely done with the material gathered in research studies. Reports of the results of this study will be used to fulfill an educational requirement.

Your child's participation is completely voluntary. If you do not give permission for your child to participate, or if your child does not want to participate once you have consented to his/her participation, it will not affect present or future services provided by Auburn University in any way. Similarly, your child or you may change your minds about participating in the study, in which case you may withdraw at any time. Parents should discuss the information on informed consent with their children.

____

JMAN SUBJECTS
FFICE OF RESEARCH
ROJECT #06-008 MR 0602
PROVED 2-13-06 TO 2-12-07

1 of 2

As a benefit, information regarding your child's sleep, including how your child's sleep compares to their peer group, will be generated through the course of the study and a report will be provided to parents.

Any questions that you have concerning the research study or your child's participation in it, before or after your consent, will be answered by Donna Lee. Please leave a message at 334-887-1933 or email her at leedong@auburn.edu, and your call or email will be returned as soon as possible. Joseph Buckhalt, Ph.D may be reached by phone at 334-844-5160 or email at buckhja@auburn.edu. For more information regarding your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334) 844-5966 or email at hsubjec@auburn.edu or irbchair@auburn.edu.

If you agree to allow your child to participate in the study, please sign and print your name and the name of your child. You may withdraw your consent and discontinue your child's participation at any time without penalty. Your signature below indicates that you have read this consent form and that you have decided to allow your child to participate. A copy of this consent form will be provided to you.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

Child's Name ____________________ Child's Date of Birth ____________________

Parent or Guardian Name ____________________ Date ____________________

I PERMIT MY CHILD TO PARTICIPATE & ALLOW DONNA LEE TO COLLECT BEHAVIOR DATA FROM MY CHILD'S TEACHER:

Parent or Guardian Signature ____________________

Investigator's Signature ____________________ Date ____________________

APPENDIX D: RECRUITMENT FOR PARTICIPATION

Concerned about your child's sleep and want to know more about sleep in childhood?

*Does your child have difficulties falling asleep or difficulties with waking in the morning?

*Did you know that research has found that sleep problems have been associated with attention difficulties and behavior problems?

FREE SLEEP CHECK-UP

Offered through participation in dissertation research on sleep

Call 887-1933

*Learn how much sleep your child gets on a nightly basis and the quality of that sleep
*Learn about sleep in childhood
*Learn about symptoms and characteristics of poor sleep and consequences of poor sleep
*Learn about basic principles of sleep hygiene and what you can do to positively affect your child's sleep
*Learn about resources available to you

Dissertation research on child sleep.Want to participate?
Looking for second grade students.
Participation Requirements:
Child to wear sleep watch at night for 4 weeks.
Parents keep a sleep log for each night the child wears sleep watch.
Parents receive an individual presentation/packet on child sleep.
Daily Behavior (4-question) Scale completed by teacher.

Name: Sex: Age: Race:

Medication: Education Classification: Regular Ed Regular Ed/Sp.Ed Support

Medical/Psychiatric Diagnosis:

1. How many hours does your child sleep at night?
2. Does your child wake up during the night?
3. Does your child exhibit daytime sleepiness?
4. Does your child have any academic difficulties?
5. Does your child have any behavioral difficulties?
6. Does your child have difficulty going to bed at night?
7. Does your child have any problems falling asleep?
8. Does your child have difficulty waking in the morning?
9. Does your child have a difficult temperament?
10. Does your child have attention problems/easily distracted?

APPENDIX E: DATA COLLECTION INSTRUMENTS

DAILY TEACHER QUESTIONNIARE

Student:

Date:

Please rate from 1 to 4. 1= never, 2=sometimes, 3=almost always, and 4=always

Alertness: on the watch, active	1	2	3	4
On-task: doing as assigned to do`	1	2	3	4
Focus: to center vision on	1	2	3	4
Concentration: to center attention on	1	2	3	4

Sleep Diary:

Date:

Time awake: Time to bed:

Did your child feel ready for bed when they went to bed ?

How many times did they wake up during last night?

Were they ready to wake this morning?

How difficult was it for them to wake up?

Illness:

Did your child experience any physical discomfort today? Mark all that apply

Headache upset stomach cold/allergy muscle/joint pain

Other

Any medications? If so, what kind?

Diet/Exercise

Meal times: Breakfast_____ Lunch_____ Dinner_____

How many caffeine drinks today? Before 12 noon____Between 12-6____After 6pm____

Did your child have any vigorous physical activity that lasted at least 15 minutes today? If so, about what time?

Check off any of these activities your child did in the HOUR before going to bed.

_____Read a Book

_____Took a Bath

_____Had a snack

_____Used a Computer

_____Talked on the Phone

_____Played with Toys/Games

_____Did Homework

_____Exercised/Played Sports

_____Played Video Games

_____Watched T.V.

_____Listened to Music

APPENDIX F: INTERVENTION

Sleep in Children: An Overview for Parents

Donna Lee, Auburn University
Research Dissertation Study
Fall 2005

- Why sleep is important
- Symptoms of sleep dysfunction
- Statistics of sleep dysfunction
- Sleep requirements
- Causes of sleep dysfunction
- Identifying a sleep dysfunction
- Principles of sleep hygiene

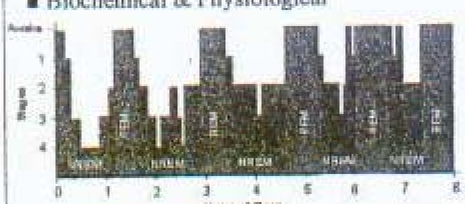
- CD was a 14-year-old boy brought in for evaluation of depressed mood, lethargy, fatigue, loss of interest in activities, and significant deterioration in school performance*
- GH was an 11-year-old girl who showed a wide range of daytime behavioral difficulties including easy distractibility, poor focussed attention, and emotional lability*

Function of Sleep

- Theories
  - Restorative
  - Memory

Sleep Processes

- REM
- NREM
- Biochemical & Physiological



Sequences of states and stages of sleep on a typical night

Learning

- Sleeping well appears to be one of the most important factors underlying success in learning.

Sleep Requirements by Age

AGE	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
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[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	

Sleep Requirements

- Age-related (developmental) processes exert profound influences on sleep regulation.

- Total sleep decreases from from 16-17 hrs. per day in the newborn period to approximately 8 hrs per night by age 18 years.

Characteristics of Poor Sleep:

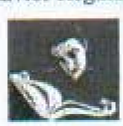
- Decreased Sleep Efficiency
- Shorter Sleep Onset
- Difficulties in Falling Asleep
- Difficulties with Morning Awakening
- Restless Sleep
- Increase in Body Movements During Sleep
- Sleep-disordered Breathing

Symptoms & Consequences of Poor Sleep

- Sleep Problems or Sleep Disorders have been associated with behavior problems and specific psychopathological disorders such as affective disorders, anxiety disorders, and Post-traumatic Stress Disorder.
- Attentional Deficits or compromised executive control increased difficulty with sustained attention, impassivity and or difficulty in behavior inhibition.

Symptoms & Consequences of Poor Sleep

- Daytime Sleepiness
- Poorer Academic Achievements
- Manifestations of Poor Behavior Regulation
- Behavior Problems
- Psychopathology
- Difficult Temperaments



Statistics of Sleep Dysfunction Among School Age Children (and Adolescents)

- 27% Bedtime Resistance
- 11% Sleep-Onset Delays
- 17% Morning Wake-up Problems
- 6.5% Night Waking
- 17% Fatigue Complaints

- Prevalence rates have ranged from lower than 5% to 43%
- Recent objective measures found that almost every fifth child (17.9%) experienced significant sleep difficulties

Causes of Sleep Dysfunction

- Psychosocial/Cultural Influences
  - Parental characteristics
  - Psychosocial stress/trauma
  - Cultural and social demands (school, work, entertainment)
- Age-related

Identifying a sleep problem

- Sleep history (from child & parent)
  - bedtime hour
  - bedtime activities
  - time of sleep onset
  - activity during the night
  - hour of morning arousal
  - daytime schedule (general, not just naptimes)
  - stressors in the child's life

Identifying a sleep problem

- Sleep history
- Sleep log
  - sleep-wake distributions over several days
- Medical history
- Family history
- Social history

Steps to take once sleep problems are identified

- local physician(s)
- contact your local sleep clinic
- educate parents/students
- develop and help parents implement plans

Principles of Sleep Hygiene for Children

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

Major Points

- Most sleep problems are either exacerbations of normal sleep behavior caused by poor sleep hygiene or daytime stressors
- Almost every fifth child (17.9%) experiences significant sleep difficulties
- Sleep problems are not easily observed
- Sleep problems make for a) less mentally alert, more inattentive, an inability to concentrate or distractibility and b) make more physically impulsive, hyperactive, or alternatively lazy.
- Sleep problems can be treated with significant results

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APPENDIX G: STATISTICAL TABLES

Table 1

Group Overall Variable Data

		GRPMIN	GRPEFF	GRPDUR	GRPAWAK	GRPACTX	GRPBEH
N	Valid	157	157	157	157	156	69
	Missing	11	11	11	11	12	99
Mean		459.9682	88.2014	523.8917	61.6752	41.8671	11.2319
Std. Error of Mean		4.81492	.54941	4.79647	2.93726	.77203	.31048
Median		472.0000	88.8700	530.0000	57.0000	41.4300	11.0000
Mode		371.00(a)	85.93	530.00	28.00	39.30	12.00
Std. Deviation		60.33076	6.88408	60.09966	36.80374	9.64263	2.57902
Variance		3639.80026	47.39052	3611.96897	1354.51560	92.98039	6.65132
Range		338.00	36.19	397.00	215.00	46.88	10.00
Minimum		255.00	63.39	348.00	2.00	21.06	6.00
Maximum		593.00	99.58	745.00	217.00	67.94	16.00
Sum		72215.00	13847.62	82251.00	9683.00	6531.27	775.00

GRPMIN = Group Minutes
GRPEFF = Group Efficiency
GRPDUR = Group Duration
GRPAWAK = Group Wake Minutes After Sleep Onset
GRPACTX = Group Activity Index
GRPBEH = Group Behavior Ratings

Table 2

Group Pre and Post-Intervention Variable Data

	N	Range	Minimum	Maximum	Mean	Std. Deviation
GRPMINBA	77	338.00	255.00	593.00	459.0519	60.83409
GRPMININ	80	302.00	270.00	572.00	460.8500	60.21293
GRPEFFBA	77	35.20	63.39	98.59	87.4443	7.14458
GRPEFFIN	80	27.53	72.05	99.58	88.9301	6.58622
GRPDURBA	77	303.00	363.00	666.00	526.6234	54.50882
GRPDURIN	80	397.00	348.00	745.00	521.2625	65.26746
GRPAWABA	77	210.00	7.00	217.00	65.1429	37.80759
GRPAWAIN	80	171.00	2.00	173.00	58.3375	35.72963
GRPACTBA	76	40.64	21.06	61.70	41.1963	10.14839
GRPACTIN	80	42.84	25.10	67.94	42.5044	9.15482
GRPBEHBA	44	9.00	7.00	16.00	11.4318	2.60052
GRPBEHIN	30	10.00	6.00	16.00	11.1333	2.52891
Valid N (listwise)	18					

GRPMINBA = Group Minutes Baseline Period
GRPMININ = Group Minutes Intervention Period
GRPEFFBA = Group Efficiency Baseline Period
GRPEFFINT = Group Efficiency Intervention Period
GRPDURBA = Group Duration Baseline Period
GRPDURIN = Group Duration Intervention Period
GRPAWABA = Group Wake Minutes After Sleep Onset Baseline Period
GRPAWAIN = Group Wake Minutes After Sleep Onset Intervention Period
GRPACTBA = Group Activity Index Baseline Period
GRPACTIN = Group Activity Index Intervention Period
GRPBEHBA = Group Behavior Ratings Baseline Period
GRPBEHIN = Group Behavior Ratings Intervention Period

Table 3

Subject 1 Variable Data

		SLEEPMI1	SLEEPEF1	SLEEPDU1	WAKEMI1	ACTIVIT1	BEHAVIO1
N	Valid	25	25	25	25	25	10
	Missing	4	4	4	4	4	19
Mean		483.4400	88.2820	550.1600	65.7200	44.3044	12.0000
Median		484.0000	89.8100	548.0000	54.0000	41.5300	12.5000
Mode		473.00	63.39(a)	452.00(a)	28.00(a)	39.30	9.00
Std. Deviation		43.63970	7.04324	39.16172	42.20142	9.26954	2.40370
Variance		1904.42333	49.60728	1533.64000	1780.96000	85.92439	5.77778
Range		205.00	31.78	174.00	193.00	29.65	6.00
Minimum		345.00	63.39	452.00	24.00	28.57	9.00
Maximum		550.00	95.17	626.00	217.00	58.22	15.00
Sum		12086.00	2207.05	13754.00	1643.00	1107.61	120.00

SLEEPMI = Sleep Minutes
SLEEPEF = Sleep Efficiency
SLEEPDU = Sleep Duration
WAKEMI = Wake Minutes After Sleep Onset
ACTIVIT = Activity Index
BEHAVIO = Behavior Rating

Table 4

Subject 2 Variable Data

		SLEEPMI 2	SLEEPEF 2	SLEEPDU 2	AWAKEMI 2	ACTIVIT 2	BEHAVIO 2
N	Valid	27	27	27	27	26	17
	Missing	2	2	2	2	3	12
Mean		385.2593	79.6563	485.5185	96.8148	46.5604	12.4118
Median		372.0000	78.7700	451.0000	87.0000	48.1550	13.0000
Mode		255.00(a)	74.94(a)	451.00(a)	57.00(a)	33.19(a)	13.00
Std. Deviation		76.18328	5.11569	91.78251	32.70502	6.69512	3.29884
Variance		5803.891 74	26.17029	8424.0284 9	1069.6182 3	44.82467	10.88235
Range		328.00	16.96	388.00	116.00	25.39	10.00
Minimum		255.00	72.05	357.00	57.00	33.19	6.00
Maximum		583.00	89.01	745.00	173.00	58.58	16.00
Sum		10402.00	2150.72	13109.00	2614.00	1210.57	211.00

SLEEPMI = Sleep Minutes
SLEEPEF = Sleep Efficiency
SLEEPDU = Sleep Duration
WAKEMI = Wake Minutes After Sleep Onset
ACTIVIT = Activity Index
BEHAVIO = Behavior Rating

Table 5

Subject 3 Variable Data

		SLEEPMI 3	SLEEPEF 3	SLEEPDU 3	AWAKEMI 3	ACTIVIT 3	BEHAVIO 3
N	Valid	27	27	27	27	27	16
	Missing	2	2	2	2	2	13
Mean		469.4815	88.7793	529.0370	58.8148	29.0300	12.5625
Median		471.0000	88.7300	533.0000	56.0000	28.4500	13.0000
Mode		441.00	84.20(a)	521.00(a)	50.00	21.06(a)	14.00
Std. Deviation		26.47404	2.16442	30.97950	13.05915	3.42709	1.67207
Variance		700.87464	4.68472	959.72934	170.54131	11.74492	2.79583
Range		102.00	7.47	103.00	48.00	18.30	4.00
Minimum		413.00	84.20	469.00	40.00	21.06	10.00
Maximum		515.00	91.67	572.00	88.00	39.36	14.00
Sum		12676.00	2397.04	14284.00	1588.00	783.81	201.00

SLEEPMI = Sleep Minutes
SLEEPEF = Sleep Efficiency
SLEEPDU = Sleep Duration
WAKEMI = Wake Minutes After Sleep Onset
ACTIVIT = Activity Index
BEHAVIO = Behavior Rating

Table 6

Subject 4 Variable Data

		SLEEPMI 4	SLEEPEF 4	SLEEPDU 4	AWAKEMI 4	ACTIVIT 4	BEHAVIO 4
N	Valid	25	25	25	25	25	16
	Missing	4	4	4	4	4	13
Mean		467.7600	85.6208	550.0400	78.7600	46.3880	9.6875
Median		475.0000	86.0800	563.0000	81.0000	44.6800	9.0000
Mode		490.00	86.19	432.00(a)	88.00	31.75(a)	9.00
Std. Deviation		48.88616	5.93383	50.39302	33.27321	7.61147	1.62147
Variance		2389.85667	35.21033	2539.45667	1107.10667	57.93444	2.62917
Range		239.00	29.80	234.00	172.00	29.95	5.00
Minimum		335.00	65.01	432.00	25.00	31.75	7.00
Maximum		574.00	94.81	666.00	197.00	61.70	12.00
Sum		11694.00	2140.52	13751.00	1969.00	1159.70	155.00

SLEEPMI = Sleep Minutes
SLEEPEF = Sleep Efficiency
SLEEPDU = Sleep Duration
WAKEMI = Wake Minutes After Sleep Onset
ACTIVIT = Activity Index
BEHAVIO = Behavior Rating

Table 7

Subject 5 Variable Data

		SLEEPMI 5	SLEEPEF 5	SLEEPDU 5	AWAKEMI 5	ACTIVIT 5	BEHAVIO 5
N	Valid	28	28	28	28	28	17
	Missing	1	1	1	1	1	12
Mean		465.1429	95.8511	487.3571	21.0357	38.3189	10.0588
Median		471.5000	95.9900	497.0000	19.5000	37.0300	10.0000
Mode		463.00	86.54(a)	477.00(a)	7.00(a)	27.56(a)	8.00
Std. Deviation		45.47015	2.78274	45.81219	14.44654	5.98466	1.88648
Variance		2067.534 39	7.74365	2098.7566 1	208.70238	35.81611	3.55882
Range		196.00	13.04	209.00	68.00	21.45	5.00
Minimum		330.00	86.54	348.00	2.00	27.56	8.00
Maximum		526.00	99.58	557.00	70.00	49.01	13.00
Sum		13024.00	2683.83	13646.00	589.00	1072.93	171.00

SLEEPMI = Sleep Minutes
SLEEPEF = Sleep Efficiency
SLEEPDU = Sleep Duration
WAKEMI = Wake Minutes After Sleep Onset
ACTIVIT = Activity Index
BEHAVIO = Behavior Rating

Table 8

Subject 6 Variable Data

		SLEEPMI6	SLEEPEF6	SLEEPDU6	AWAKEMI6	ACTIVIT6
N	Valid	25	25	25	25	25
	Missing	4	4	4	4	4
Mean		493.3200	90.7384	548.2800	51.2000	47.8660
Median		487.0000	90.7600	536.0000	49.0000	48.6600
Mode		484.00(a)	79.19(a)	530.00	48.00(a)	30.94(a)
Std. Deviation		42.23320	4.07951	39.79585	24.02950	8.24777
Variance		1783.6433 3	16.64244	1583.71000	577.41667	68.02569
Range		202.00	18.76	164.00	113.00	37.00
Minimum		391.00	79.19	482.00	10.00	30.94
Maximum		593.00	97.95	646.00	123.00	67.94
Sum		12333.00	2268.46	13707.00	1280.00	1196.65

SLEEPMI = Sleep Minutes
SLEEPEF = Sleep Efficiency
SLEEPDU = Sleep Duration
WAKEMI = Wake Minutes After Sleep Onset
ACTIVIT = Activity Index
BEHAVIO = Behavior Rating

Table 9

Subject 1 Baseline & Intervention Variable Data

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
MIN1BASE	6	170.00	345.00	515.00	454.5000	60.02583	3603.100
MIN1INTE	19	122.00	428.00	550.00	492.5789	34.22039	1171.035
EFF1BASE	6	27.70	63.39	91.09	82.0483	9.80446	96.127
EFF1INTE	19	15.34	79.83	95.17	90.2505	4.73263	22.398
DUR1BASE	6	46.00	529.00	575.00	557.5000	16.93222	286.700
DUR1INTE	19	174.00	452.00	626.00	547.8421	44.06342	1941.585
AWAKE1BA	6	167.00	50.00	217.00	101.6667	59.71823	3566.267
AWAK1INT	19	95.00	24.00	119.00	54.3684	28.58751	817.246
ACTIV1BA	6	11.33	46.89	58.22	53.0667	4.66093	21.724
ACTIV1IN	19	28.81	28.57	57.38	41.5374	8.65200	74.857
BEHBASE	3	6.00	9.00	15.00	12.0000	3.00000	9.000
BEHINTER	7	6.00	9.00	15.00	12.0000	2.38048	5.667
Valid N (listwise)	1						

MIN1BASE = Sleep Minutes Baseline Period
MIN1INTE = Sleep Minutes Intervention Period
EFF1BASE = Sleep Efficiency Baseline Period
EFF1INTE = Sleep Efficiency Intervention Period
DUR1BASE = Sleep Duration Baseline Period
DUR1INTE = Sleep Duration Intervention Period
AWAKE1BA = Wake Time After Sleep Onset Baseline Period
AWAK1INT = Wake Time After Sleep Onset Intervention Period
ACTI1BA = Activity Index Baseline Period
ACTIV1IN = Activity Index Intervention Period
BEHBASE = Behavior Rating Baseline Period
BEHINTER =Behavior Rating Intervention Period

Table 10

Subject 2 Baseline & Intervention Variable Data

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
MIN2BASE	14	328.00	255.00	583.00	384.2857	82.15785	6749.912
MIN2INTE	13	302.00	270.00	572.00	386.3077	72.52860	5260.397
EFF2BASE	14	16.89	72.12	89.01	79.9143	5.38620	29.011
EFF2INTE	13	13.88	72.05	85.93	79.3785	5.01121	25.112
AWAK2BAS	14	81.00	57.00	138.00	92.9286	27.48276	755.302
AWAK2INT	13	116.00	57.00	173.00	101.0000	38.24483	1462.667
DUR2BASE	14	292.00	363.00	655.00	483.8571	85.01209	7227.055
DUR2INTE	13	388.00	357.00	745.00	487.3077	102.05912	10416.064
ACTIV2BA	13	17.50	36.99	54.49	47.6200	5.70682	32.568
ACTIV2IN	13	25.39	33.19	58.58	45.5008	7.64095	58.384
BEH2BASE	10	9.00	7.00	16.00	13.2000	2.89828	8.400
BEH2INTE	7	10.00	6.00	16.00	11.2857	3.72891	13.905
Valid N (listwise)	5						

MIN2BASE = Sleep Minutes Baseline Period
MIN2INTE = Sleep Minutes Intervention Period
EFF2BASE = Sleep Efficiency Baseline Period
EFF2INTE = Sleep Efficiency Intervention Period
DUR2BASE = Sleep Duration Baseline Period
DUR2INTE = Sleep Duration Intervention Period
AWAKE2BA = Wake Time After Sleep Onset Baseline Period
AWAK2INT = Wake Time After Sleep Onset Intervention Period
ACTI2BA = Activity Index Baseline Period
ACTIV2IN = Activity Index Intervention Period
BEH2BASE = Behavior Rating Baseline Period
BEH2INTE=Behavior Rating Intervention Period

Table 11

Subject 3 Baseline & Intervention Variable Data

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
MIN3BASE	20	102.00	413.00	515.00	471.6000	27.35036	748.042
MIN3INTE	7	68.00	437.00	505.00	463.4286	24.71071	610.619
EFF3BASE	20	5.75	85.92	91.67	88.8800	1.96320	3.854
EFF3INTE	7	7.24	84.20	91.44	88.4914	2.82227	7.965
DUR3BASE	20	103.00	469.00	572.00	530.7000	30.34382	920.747
DUR3INTE	7	94.00	478.00	572.00	524.2857	34.75013	1207.571
AWAK3BAS	20	39.00	40.00	79.00	58.1000	11.60717	134.726
AWAK3INT	7	47.00	41.00	88.00	60.8571	17.48741	305.810
ACTIV3BA	20	18.30	21.06	39.36	29.1615	3.56318	12.696
ACTIV3IN	7	10.24	25.10	35.34	28.6543	3.23535	10.467
BEH3BASE	11	4.00	10.00	14.00	12.5455	1.75292	3.073
BEH3INTE	5	4.00	10.00	14.00	12.6000	1.67332	2.800
Valid N (listwise)	5						

MIN3BASE = Sleep Minutes Baseline Period
MIN3INTE = Sleep Minutes Intervention Period
EFF3BASE = Sleep Efficiency Baseline Period
EFF3INTE = Sleep Efficiency Intervention Period
DUR3BASE = Sleep Duration Baseline Period
DUR3INTE = Sleep Duration Intervention Period
AWAKE3BA = Wake Time After Sleep Onset Baseline Period
AWAK3INT = Wake Time After Sleep Onset Intervention Period
ACTIV3BA = Activity Index Baseline Period
ACTIV3IN = Activity Index Intervention Period
BEH3BASE = Behavior Rating Baseline Period
BEH3INTE=Behavior Rating Intervention Period

Table 12

Subject 4 Baseline & Intervention Variable Data

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
MIN4BASE	18	203.00	371.00	574.00	472.2222	46.22013	2136.301
MIN4INTE	7	169.00	335.00	504.00	456.2857	57.38674	3293.238
EFF4BASE	18	28.64	65.01	93.65	85.8361	6.23847	38.918
EFF4INTE	7	17.26	77.55	94.81	85.0671	5.48413	30.076
DUR4BASE	18	225.00	441.00	666.00	553.8333	47.20450	2228.265
DUR4INTE	7	160.00	432.00	592.00	540.2857	60.74733	3690.238
AWAK4BAS	18	169.00	28.00	197.00	78.4444	36.10479	1303.556
AWAK4INT	7	84.00	25.00	109.00	79.5714	27.09156	733.952
ACTIV4BA	18	29.95	31.75	61.70	47.0850	8.33448	69.463
ACTIV4IN	7	14.74	37.16	51.90	44.5957	5.45156	29.719
BEH4BASE	10	5.00	7.00	12.00	9.5000	1.84089	3.389
BEH4INTE	4	2.00	9.00	11.00	9.7500	.95743	.917
Valid N (listwise)	3						

MIN4BASE = Sleep Minutes Baseline Period
MIN4INTE = Sleep Minutes Intervention Period
EFF4BASE = Sleep Efficiency Baseline Period
EFF4INTE = Sleep Efficiency Intervention Period
DUR4BASE = Sleep Duration Baseline Period
DUR4INTE = Sleep Duration Intervention Period
AWAKE4BA = Wake Time After Sleep Onset Baseline Period
AWAK4INT = Wake Time After Sleep Onset Intervention Period
ACTI4BA = Activity Index Baseline Period
ACTIV4IN = Activity Index Intervention Period
BEH4BASE = Behavior Rating Baseline Period
BEH4INTE =Behavior Rating Intervention Period

Table 13

Subject 5 Baseline & Intervention Variable Data

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
MIN5BASE	14	88.00	438.00	526.00	485.6429	26.24033	688.555
MIN5INTE	14	182.00	330.00	512.00	444.6429	51.96538	2700.401
EFF5BASE	14	4.16	94.43	98.59	96.4714	1.36442	1.862
EFF5INTE	14	13.04	86.54	99.58	95.2307	3.65957	13.392
DUR5BASE	14	112.00	445.00	557.00	504.1429	28.11476	790.440
DUR5INTE	14	184.00	348.00	532.00	470.5714	54.42103	2961.648
AWAK5BAS	14	24.00	7.00	31.00	17.8571	7.28388	53.055
AWAK5INT	14	68.00	2.00	70.00	24.2143	18.93787	358.643
ACTIV5BA	14	18.41	30.60	49.01	37.6421	5.46322	29.847
ACTIV5IN	14	20.19	27.56	47.75	38.9957	6.59954	43.554
BEH5BASE	10	5.00	8.00	13.00	10.2000	2.04396	4.178
BEH5INTE	7	4.00	8.00	12.00	9.8571	1.77281	3.143
Valid N (listwise)	7						

MIN5BASE = Sleep Minutes Baseline Period
MIN5INTE = Sleep Minutes Intervention Period
EFF5BASE = Sleep Efficiency Baseline Period
EFF5INTE = Sleep Efficiency Intervention Period
DUR5BASE = Sleep Duration Baseline Period
DUR5INTE = Sleep Duration Intervention Period
AWAK5BA = Wake Time After Sleep Onset Baseline Period
AWAK5INT = Wake Time After Sleep Onset Intervention Period
ACTI5BA = Activity Index Baseline Period
ACTIV5IN = Activity Index Intervention Period
BEH5BASE = Behavior Rating Baseline Period
BEH5INTE =Behavior Rating Intervention Period

Table 14

Subject 6 Baseline & Intervention Variable Data

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
MIN6BASE	5	135.00	458.00	593.00	501.8000	55.50405	3080.700
MIN6INTE	20	172.00	391.00	563.00	491.2000	39.75928	1580.800
EFF6BASE	5	8.65	85.93	94.58	89.7740	3.09498	9.579
EFF6INTE	20	18.76	79.19	97.95	90.9795	4.32429	18.699
DUR6BASE	5	109.00	518.00	627.00	558.0000	44.14182	1948.500
DUR6INTE	20	164.00	482.00	646.00	545.8500	39.48654	1559.187
AWAK6BAS	5	41.00	34.00	75.00	56.2000	14.85598	220.700
AWAK6INT	20	113.00	10.00	123.00	49.9500	25.97463	674.682
ACTIV6BA	5	17.24	37.80	55.04	47.1420	6.29087	39.575
ACTIV6IN	20	37.00	30.94	67.94	48.0470	8.79904	77.423
Valid N (listwise)	4						

MIN6BASE = Sleep Minutes Baseline Period
MIN6INTE = Sleep Minutes Intervention Period
EFF6BASE = Sleep Efficiency Baseline Period
EFF6INTE = Sleep Efficiency Intervention Period
DUR6BASE = Sleep Duration Baseline Period
DUR6INTE = Sleep Duration Intervention Period
AWAK6BA = Wake Time After Sleep Onset Baseline Period
AWAK6INT = Wake Time After Sleep Onset Intervention Period
ACTI6BAS= Activity Index Baseline Period
ACTIV6INT = Activity Index Intervention Period
BEH6BA = Behavior Rating Baseline Period
BEH6IN=Behavior Rating Intervention Period

Table 15

Individual Subject Weekly Mean Values by Variable

Sub1	Week 1*	Week 2	Week 3	Week 4
Avg Min	454	**510.57**	**484.40**	**480.43** *
Avg Eff	81.71	**89.92**	**87.47**	**92.57** *
Avg Dur	557.5	**568.14**	**559.20**	519.43
Avg Awak	101.67	**57.55**	**71.00**	**39.00** *
Avg ActIn	53.07	**42.82**	**48.19**	**36.58** *

Sub 2	Week 1	Week 2*	Week 3	Week 4	(Wk 4 sick control)
Avg Min	375.43	396.00	**395.50**	378.43*	**415** *+
Avg Eff	78.54	81.29	**81.26**	78.30	74.72
Avg Dur	479.43	488.29	**489.33**	**485.57** *	**549.25** *+
Avg Awak	102.00	83.86	93.83	107.14	135.25
Avg ActIn	51.05	45.01	**45.66**	**45.36** *	**45.35** *+

Sub 3	Week 1	Week 2	Week 3*	Week 4
Avg Min	485.14	462.17	466.14	463.43
Avg Eff	88.52	90.20	88.11	88.49
Avg Dur	548.14	512.33	529.00	524.29
Avg Awak	63.00	50.17	62.86	60.86 *
Avg ActIn	29.22	29.28	29.00	**28.65** *

Sub 4	Week 1	sick	Week 2	Week 3*	Week 4
Avg Min	469.33	475.5	453.14	502.40	456.29
Avg Eff	82.04	83.67	87.40	88.20	85.07 *
Avg Dur	575.17	571	519.43	576.40	540.29
Avg Awak	101.33	91.5	66.29	68.00	79.57 *
Avg ActIn	55.88	56.49	44.18	40.59	**44.60** *+

Sub 5	Week 1	Week 2*	Week 3	Week 4	(Wk 4 sick control)
Avg Min	479.71	491.57	440.00	444.64	457
Avg Eff	97.19	95.76	96.21	94.87	**97.87** *+
Avg Dur	494.86	513.43	458.43	470.57	477.33
Avg Awak	13.86	21.86	17.57	24.21	**16.67** +
Avg ActIn	35.45	39.84	**37.42**	39.00	39.47

Sub 6	Week 1*	Week 2	Week 3	Week 4
Avg Min	501.8	486.67	**516.14**	483.43
Avg Eff	89.77	88.78	**90.89**	**92.96** *+
Avg Dur	558	549.17	**568.57**	520.29
Avg Awak	56.20	62.33	**52.43**	**36.86** *+
Avg ActIn	47.14	53.51	49.73	**40.97** *+

* Intervention Week
Bold = Baseline Improvement
* = 4th week Improvement vs. 1st week
+= Improvement when sickness controlled

Table 16

Sleep Variable Improvement by Period

Subject	Post-Intervention	Last Week vs. Baseline	Last Week vs. First Week
1	Min, Eff, Awak, Act	Min, Eff, Awak, Act	Min, Eff, Awak, Act
2	Min, Dur, Act	Min*, Dur, Act	Min, Dur, Act
3	Act	Act	Awak, Act
4	Act	Act	Eff, Awak, Act
5	Eff*, Awak*	Eff*, Awak*	Eff*, Awak
6	Eff, Awak, Act*	Eff, Awak, Act	Eff, Awak, Act

Long-Term Improvement
(Improvement found both when Post-Intervention>Baseline & 4th Week> Baseline)

Sub1: Min, Eff, Awak, Activity	4/5
Sub2: Min*, Dur, Activity	3/5
Sub 3: Activity	1/5
Sub 4: Activity	1/5
Sub 5: Efficiency*, Awake*	2/5
Sub 6: Eff, Awak, Activity*	3/5

*(When sickness was controlled for and a difference was found)

Table 17

Subject 1 Improvement Over Baseline Analysis

Minutes	Efficiency	Duration	AwakeMin	Activity	Day
345.00	63.39	562.00	217.00	57.12	1
488.00	84.87	575.00	87.00	50.78	2
437.00	80.04	546.00	109.00	46.89	3
485.00	86.51	566.00	75.00	56.01	4
515.00	91.09	567.00	50.00	49.38	5
.	.	.	.	.	6
457.00	86.39	529.00	72.00	58.22	7
454.5	82.04	557.5	101.67	53.07	AVG
67%	67%	67%	67%	50%	
540.00	**94.74**	**570.00**	**30.00**	**39.30**	8
460.00	**84.71**	543.00	**83.00**	**51.20**	9
508.00	**85.38**	**595.00**	**87.00**	**52.61**	10
550.00	**87.86**	**626.00**	**76.00**	**39.14**	11
548.00	**93.68**	**585.00**	**37.00**	**40.17**	12
475.00	**92.59**	513.00	**38.00**	**30.18**	13
493.00	**90.46**	545.00	**52.00**	**39.30**	14
509.00	**94.79**	537.00	**28.00**	**41.53**	15
477.00	79.83	**610.00**	119.00	57.38	16
514.00	**86.97**	**591.00**	**77.00**	**44.33**	17
453.00	81.47	556.00	103.00	56.65	18
.	.	.	.	.	19
.	.	.	.	.	20
469.00	**94.27**	502.00	**28.00**	**41.40**	21
484.00	**93.80**	516.00	**32.00**	**31.59**	22
487.00	**88.87**	548.00	**61.00**	**50.18**	23
473.00	**92.38**	512.00	**39.00**	**41.02**	24
428.00	**94.69**	452.00	**24.00**	**35.84**	25
542.00	**93.29**	**581.00**	**39.00**	**37.69**	26
473.00	**95.17**	497.00	**26.00**	**28.57**	27
476.00	**89.81**	530.00	**54.00**	**31.13**	28
.	.	.	.	.	
17/19	17/19	7/19	17/19	17/19	
89%	89%	37%	89%	89%	

Bold=Improvement Over Baseline Mean
Blue indicates percentage of days met or exceeded baseline mean value

Table 18

Subject 2 Improvement Over Baseline Analysis

Minutes	Efficiency	Duration	AwakeMin	Activity	Day
341.00	84.32	429.00	66.00	52.68	1
314.00	74.94	419.00	105.00	52.98	2
366.00	86.52	423.00	57.00	49.88	3
480.00	78.16	614.00	133.00	48.86	4
448.00	78.77	573.00	114.00	48.69	5
302.00	74.94	403.00	101.00		6
357.00	72.12	495.00	138.00	50.91	7
352.00	81.18	457.00	67.00	54.49	8
372.00	82.48	451.00	79.00	41.46	9
373.00	83.07	449.00	76.00	40.76	10
583.00	89.01	655.00	72.00	40.92	11
419.00	76.04	551.00	132.00	47.55	12
255.00	72.29	363.00	87.00	52.89	13
418.00	84.96	492.00	74.00	36.99	14
384.29	79.91	483.86	92.92	47.62	AVG
36%	50%	43%	57%	38%	
317.00	**83.86**	378.00	**61.00**	**36.77**	15
403.00	**85.74**	470.00	**67.00**	**33.19**	16
426.00	**80.53**	**529.00**	103.00	50.28	17
427.00	75.58	**565.00**	138.00	58.58	18
422.00	76.73	**550.00**	128.00	56.18	19
378.00	**85.14**	444.00	**66.00**	**38.96**	20
.	.	.	.	.	21
270.00	75.63	357.00	**87.00**	**47.62**	22
371.00	**84.32**	440.00	**69.00**	**43.86**	23
348.00	**85.93**	405.00	**57.00**	**44.69**	24
333.00	74.00	450.00	117.00	49.78	25
397.00	72.05	**551.00**	154.00	50.27	26
572.00	76.78	**745.00**	173.00	**44.30**	27
358.00	75.63	451.00	93.00	**37.03**	28
6/13	6/13	5/13	6/13	8/13	
46% 60%	46% 40%	38% 50%	46% 30%	62% 50%	

Sick days 22-24

Bold=Improvement Over Baseline Mean

Blue indicates percentage of days met or exceeded baseline mean value (red=percentage of days meeting/exceeding baseline with sick days controlled for)

Table 19

Subject 3 Improvement Over Baseline Analysis

Minutes	Efficiency	Duration	AwakeMin	Activity	Day
504.00	88.73	568.00	64.00	32.39	1
482.00	85.92	561.00	79.00	26.92	2
471.00	87.55	538.00	67.00	30.48	3
475.00	90.48	525.00	50.00	30.67	4
515.00	90.19	571.00	56.00	27.50	5
464.00	85.93	540.00	76.00	29.81	6
485.00	90.82	534.00	49.00	26.78	7
450.00	90.18	499.00	49.00	27.86	8
437.00	86.71	504.00	47.00	29.56	9
499.00	90.89	549.00	50.00	27.32	10
.	.	.	.	.	11
470.00	90.21	521.00	51.00	33.78	12
477.00	91.55	521.00	44.00	30.52	13
440.00	91.67	480.00	40.00	26.67	14
441.00	86.98	507.00	66.00	28.60	15
441.00	87.67	503.00	62.00	39.36	16
480.00	86.64	554.00	74.00	30.14	17
483.00	90.62	533.00	50.00	28.14	18
497.00	86.89	572.00	75.00	29.02	19
413.00	88.06	469.00	56.00	26.65	20
508.00	89.91	565.00	57.00	21.06	21
471.6	88.88	530.70	58.10	29.16	AVG
55%	50%	55%	60%	55%	
479.00	88.05	**544.00**	65.00	**27.39**	22
441.00	85.63	515.00	74.00	35.34	23
470.00	**91.44**	514.00	**44.00**	**25.10**	24
437.00	**91.42**	478.00	**41.00**	**28.45**	25
505.00	88.29	**572.00**	67.00	**27.10**	26
443.00	**90.41**	490.00	**47.00**	**27.76**	27
469.00	84.20	**557.00**	88.00	**29.44**	28
2/7	3/7	3/7	3/7	6/7	
29%	43%	43%	43%	86%	

No sickness

Bold=Improvement Over Baseline Mean

Blue indicates percentage of days met or exceeded baseline mean value

Table 20

Subject 4 Improvement Over Baseline Analysis

Minutes	Efficiency	Duration	AwakeMin	Activity	Day
371.00	65.01	577.00	197.00	61.70	1
453.00	82.82	547.00	94.00	51.01	2
506.00	86.08	597.00	81.00	59.46	3
535.00	90.99	588.00	53.00	50.17	4
.	.	.	.	.	5
490.00	85.66	572.00	82.00	54.37	6
461.00	81.67	570.00	101.00	58.60	7
507.00	88.79	571.00	64.00	48.16	8
481.00	91.44	526.00	45.00	44.68	9
460.00	82.88	555.00	95.00	40.36	10
452.00	83.70	540.00	88.00	51.85	11
436.00	84.50	516.00	80.00	50.39	12
423.00	86.86	487.00	64.00	42.09	13
413.00	93.65	441.00	28.00	31.75	14
487.00	86.19	565.00	78.00	41.95	15
475.00	90.65	524.00	49.00	35.31	16
490.00	91.65	564.00	44.00	39.89	17
.	.	.	.	.	18
574.00	86.19	666.00	92.00	44.59	19
.	.	.	.	.	20
486.00	86.32	563.00	77.00	41.20	21
472.22	85.83	553.83	78.44	47.09	AVG
473.93	87.15	547.14	70.5	44.65	(sick controlled)
56% 57%	61% 36%	61% 57%	50% 43%	50% 57%	
504.00	85.14	**592.00**	88.00	**37.16**	22
491.00	**87.52**	**591.00**	**69.00**	**41.29**	23
473.00	85.38	**554.00**	81.00	**40.43**	24
335.00	77.55	432.00	97.00	48.38	25
444.00	80.29	553.00	109.00	51.90	26
490.00	84.78	**578.00**	88.00	49.65	27
457.00	**94.81**	482.00	**25.00**	**43.36**	28
4/7	2/7	4/7	2/7	4/7	
57% 43%	29%	57% 71%	29%	57%	

Sick days 1-4

Bold=Improvement Over Baseline Mean

Blue indicates percentage of days met or exceeded baseline mean value (red=percentage of days meeting/exceeding baseline with sick days controlled for)

Table 21

Subject 5 Improvement Over Baseline Analysis

Minutes	Efficiency	Duration	Awake	Activity	Day
491.00	98.59	498.00	7.00	32.13	1
489.00	97.80	500.00	11.00	30.60	2
463.00	96.60	488.00	16.00	33.20	3
499.00	95.96	520.00	21.00	37.31	4
454.00	95.18	477.00	23.00	40.25	5
438.00	98.43	445.00	7.00	33.03	6
524.00	97.76	536.00	12.00	41.60	7
526.00	94.43	557.00	31.00	49.01	8
492.00	95.53	515.00	23.00	32.82	9
472.00	95.93	492.00	20.00	35.98	10
481.00	94.50	509.00	28.00	44.99	11
458.00	96.02	477.00	19.00	37.32	12
504.00	96.37	523.00	19.00	35.56	13
508.00	97.50	521.00	13.00	43.19	14
485.64	96.47	504.14	17.86	37.64	AVG
57%	43%	50%	43%	64%	
465.00	94.32	493.00	28.00	**35.09**	15
330.00	94.83	348.00	18.00	**31.32**	16
462.00	**99.35**	465.00	**3.00**	**32.90**	17
483.00	95.08	**508.00**	25.00	**27.56**	18
476.00	92.43	**515.00**	39.00	45.05	19
371.00	**98.09**	384.00	**7.00**	44.27	20
493.00	**99.40**	496.00	**3.00**	45.77	21
388.00	**97.08**	431.00	32.00	42.92	22
512.00	**96.97**	**528.00**	**16.00**	**36.17**	23
471.00	**99.58**	473.00	**2.00**	39.32	24
400.00	93.92	429.00	25.00	**33.33**	25
463.00	94.88	488.00	25.00	47.75	26
452.00	90.76	498.00	46.00	**36.75**	27
459.00	86.54	**532.00**	70.00	47.74	28
2/14	6/14	4/14	5/14	7/14	
14% 20%	43% 60%	29% 30%	36% 50%	50% 50%	

Sick days 25-28

Bold=Improvement Over Baseline Mean

Blue indicates percentage of days met or exceeded baseline mean value (red=percentage of days meeting/exceeding baseline with sick days controlled for)

Table 22

Subject 6 Improvement Over Baseline Analysis

Minutes	Efficiency	Duration	AwakeMin	Activity	Day
458.00	85.93	533.00	75.00	47.09	1
481.00	89.74	536.00	55.00	55.04	2
514.00	89.24	576.00	62.00	49.83	3
463.00	89.38	518.00	55.00	45.95	4
.	.	.	.	.	5
593.00	94.58	627.00	34.00	37.80	6
.	.	.	.	.	7
501.8	89.77	558.00	56.20	47.71	AVG
40%	20%	40%	60%	60%	
459.00	86.62	530.00	70.00	50.57	8
468.00	79.19	**591.00**	123.00	67.94	9
470.00	88.67	530.00	60.00	50.94	10
.	.	.	.	.	11
555.00	**92.04**	**603.00**	**48.00**	55.06	12
391.00	**97.26**	511.00	**14.00**	**37.77**	13
484.00	88.87	530.00	59.00	63.77	14
501.00	**90.11**	556.00	**55.00**	52.70	15
538.00	**95.39**	**564.00**	**26.00**	48.76	16
527.00	**93.94**	**561.00**	**34.00**	48.66	17
509.00	**91.38**	557.00	**48.00**	**43.45**	18
563.00	87.15	**646.00**	83.00	54.02	19
491.00	85.69	**573.00**	82.00	50.61	20
484.00	**92.54**	523.00	**39.00**	49.90	21
501.00	**91.09**	550.00	**49.00**	47.82	22
487.00	**94.02**	518.00	**31.00**	**39.38**	23
506.00	**94.40**	536.00	**30.00**	**40.11**	24
478.00	**97.95**	488.00	**10.00**	**30.94**	25
511.00	**90.76**	**563.00**	**52.00**	**42.98**	26
467.00	**92.48**	505.00	**38.00**	**37.43**	27
434.00	**90.04**	482.00	**48.00**	48.13	28
7/20	14/20	7/20	14/20	7/20	
35% 36%	70% 71%	35% 36%	70% 71%	35% 43%	

Bold=Improvement Over Baseline Mean

Blue indicates percentage of days met or exceeded baseline mean value (red=percentage of days meeting/exceeding baseline with sick days controlled)

Table 23

Percentage of days meeting/exceeding baseline mean during post-intervention with summary

Subject	Minutes	b	Efficiency	b	Duration	b	Awake	b	Activity	b
1	**89%**	67%	**89%**	67%	37%	67%	**89%**	67%	**89%**	50%
2	**46/60%**	36%	46/40%	50%	38/**50%**	43%	46/30%	57%	**62/50%**	38%
3	29%	55%	43**%**	50%	43%	55%	43%	60%	**86%**	55%
4	**57**/43**%**	56/57%	29%	61/36%	57/**71%**	61/57%	29%	50/43%	**57%**	50/57%
5	14/20%	57%	**43/60%**	43%	29/30%	50%	36/**50%**	43%	50%	64%
6	35/36%	40%	**70/71%**	20%	35/36%	40%	**70/71%**	60%	35/43%	**60**%

b = baseline period
Bold = Increase in Frequency Found
/ = Sickness Controlled

Table Summary

-Activity Index improved for 4 of 6 subjects (for 1 subject, after controlling for sickness, improvement was found)

-Efficiency improved for 3 of 6 subjects (for 1 subject, efficiency stayed same but after controlling for sickness, improvement was found)

-Minutes improved for 3 of 6 subjects (for 1 subject, when sickness was controlled for, no improvement was found= 2/6)

-Duration improved for 2 of 6 subjects only when sickness was controlled

-Awake after sleep onset improved for 2 of 6 subjects (3 of 6 when sickness controlled for)

Table 24

Daily Teacher Behavior Rating Scale Scores Summary By Subject

Subject 1 Baseline	Avg12	Sub 2 Baseline	Avg 13.2
1st week	Avg 12	1st week	Avg 12.8
Intervention	Avg 12	Intervention	Avg 11.3
Last Week	Avg 12.3*+	Last Week	Avg 13*
Sub 3 Baseline	Avg 12.5	Sub 4 Baseline	Avg 9.5
1st week	Avg 12.2	1st week	Avg 9.2
Intervention	**Avg 12.6**	Intervention	**Avg 9.75**
Last Week	Avg 12.6* + ^	Last Week	Avg 9.75* + ^

Sub 5 Baseline	Avg 10.2
1st week	Avg 11.2
Intervention	Avg 9.85
Last Week	Avg 10.6

Bold = Post-Intervention Improvement
***** = 4th week Improvement vs. 1st week
+ = 4th week Improvement vs. Baseline
^ = Long-term Improvement (Improvement Post-Intervention vs. Baseline and 4th week vs. Baseline)

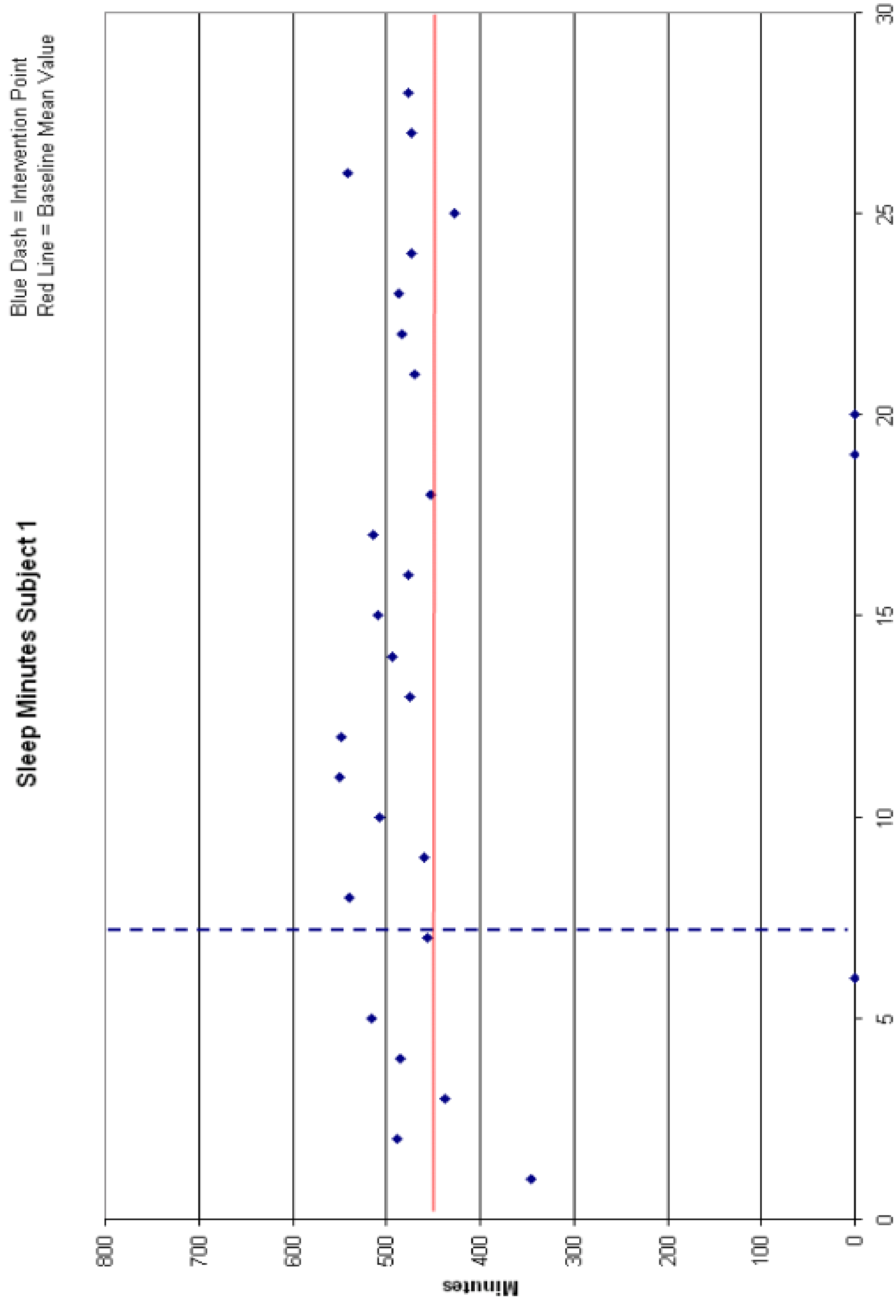
Table 25

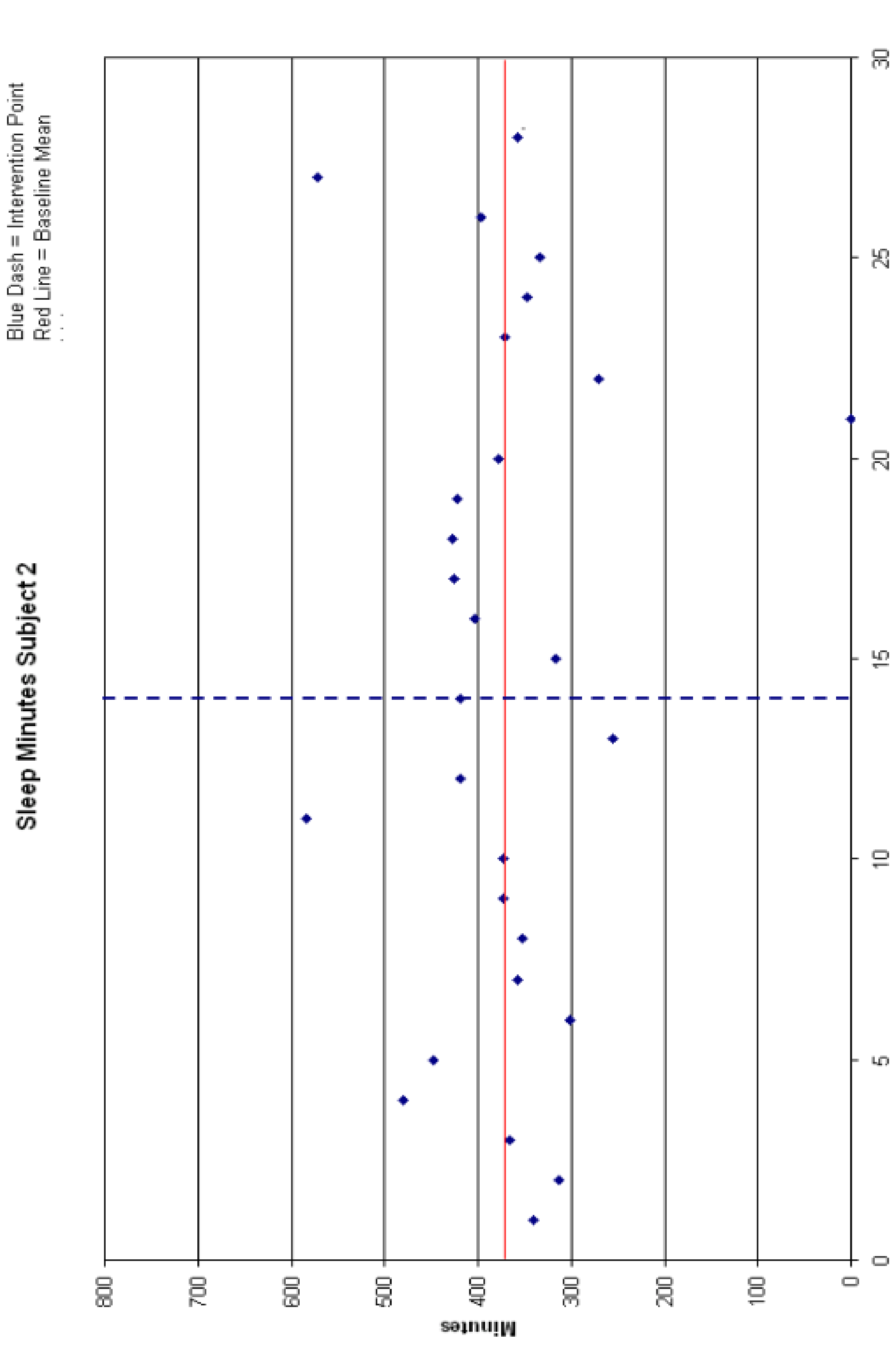
Descriptive Statistics for Comparisons Between Boys and Girls

	N	Minimum	Maximum	Mean	Std. Deviation
Boys Sleep Min	77	335.00	574.00	473.4545	40.55780
Boys Sleep Eff	77	63.39	95.17	87.5923	5.50661
Boys Sleep Dur	77	432.00	666.00	542.7143	41.43570
Boys Wake Min	77	24.00	217.00	67.5325	32.24764
Boys Activity Ind	77	21.06	61.70	39.6249	10.56291
Girls Sleep Min	80	255.00	593.00	446.9875	72.50569
Girls Sleep Eff	80	72.05	99.58	88.7876	7.98126
Girls Sleep Dur	80	348.00	745.00	505.7750	69.30431
Girls Wake Min	80	2.00	173.00	56.0375	40.10854
Girls Activity Ind	79	27.56	67.94	44.0525	8.13967

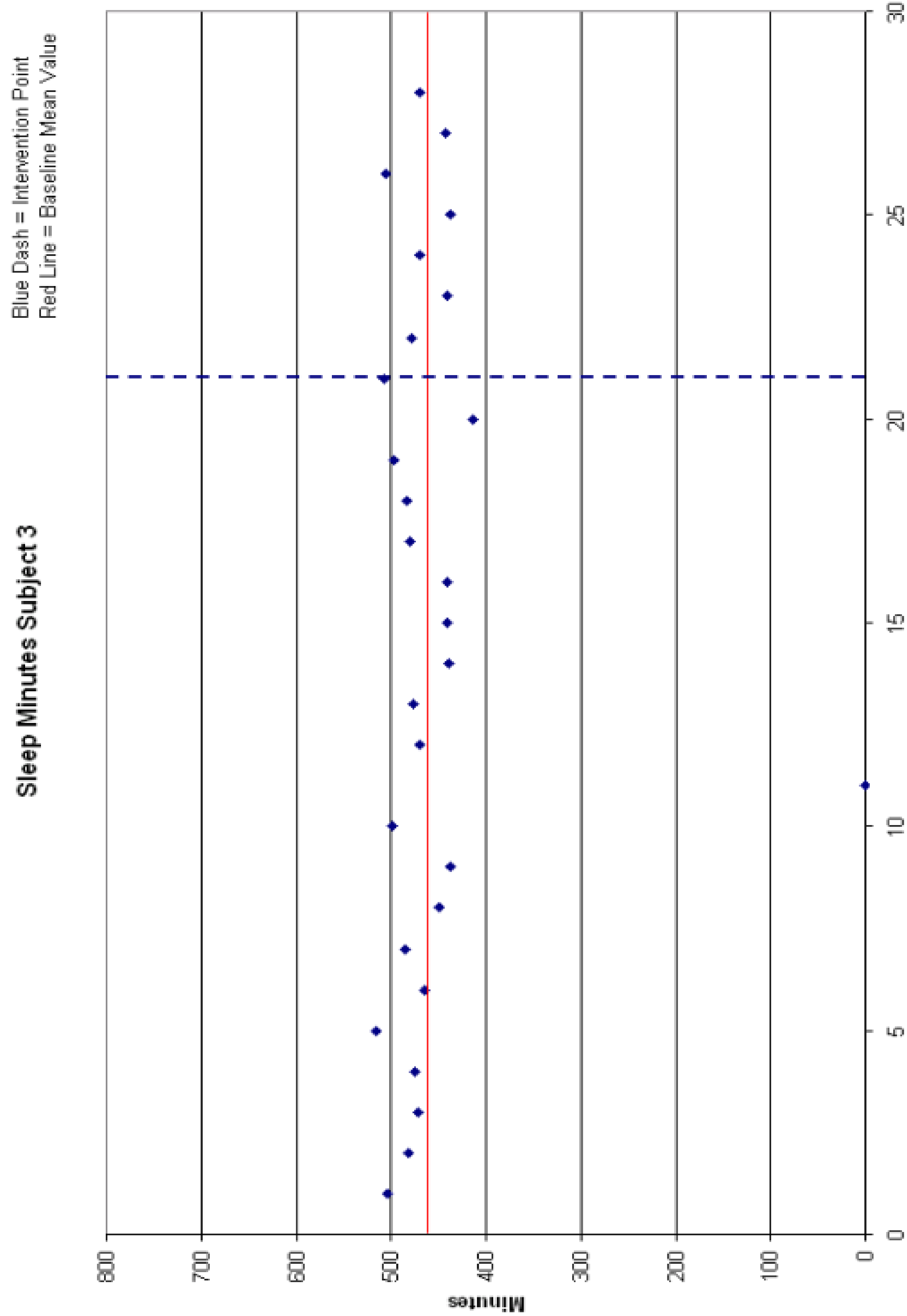
Min = Sleep Minutes
Eff = Sleep Efficiency
Dur = Sleep Duration
Wake Min = Wake Minutes After Sleep Onset
Activity Ind = Activity Index

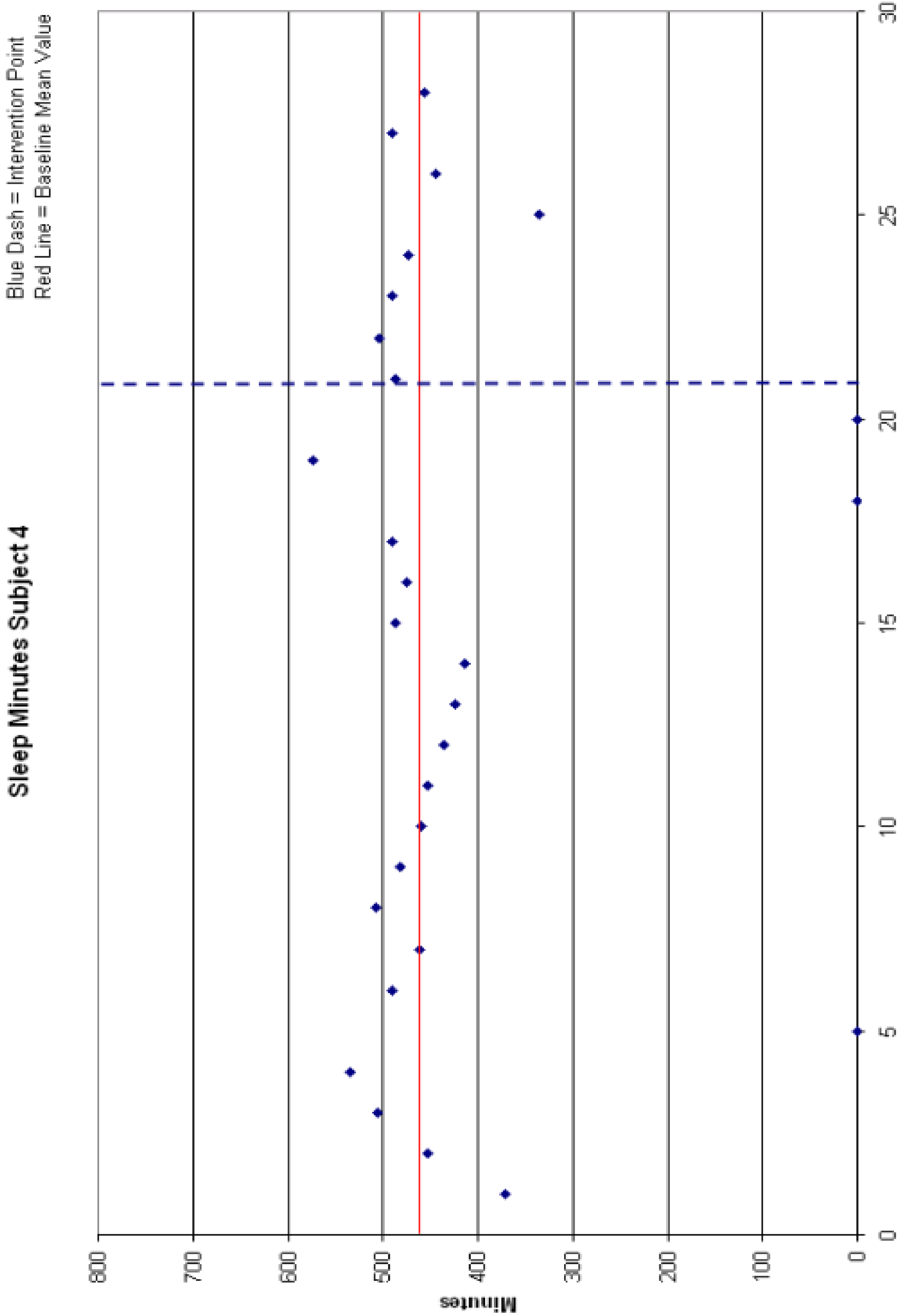
APPENDIX H: GRAPHICAL DISPLAYS

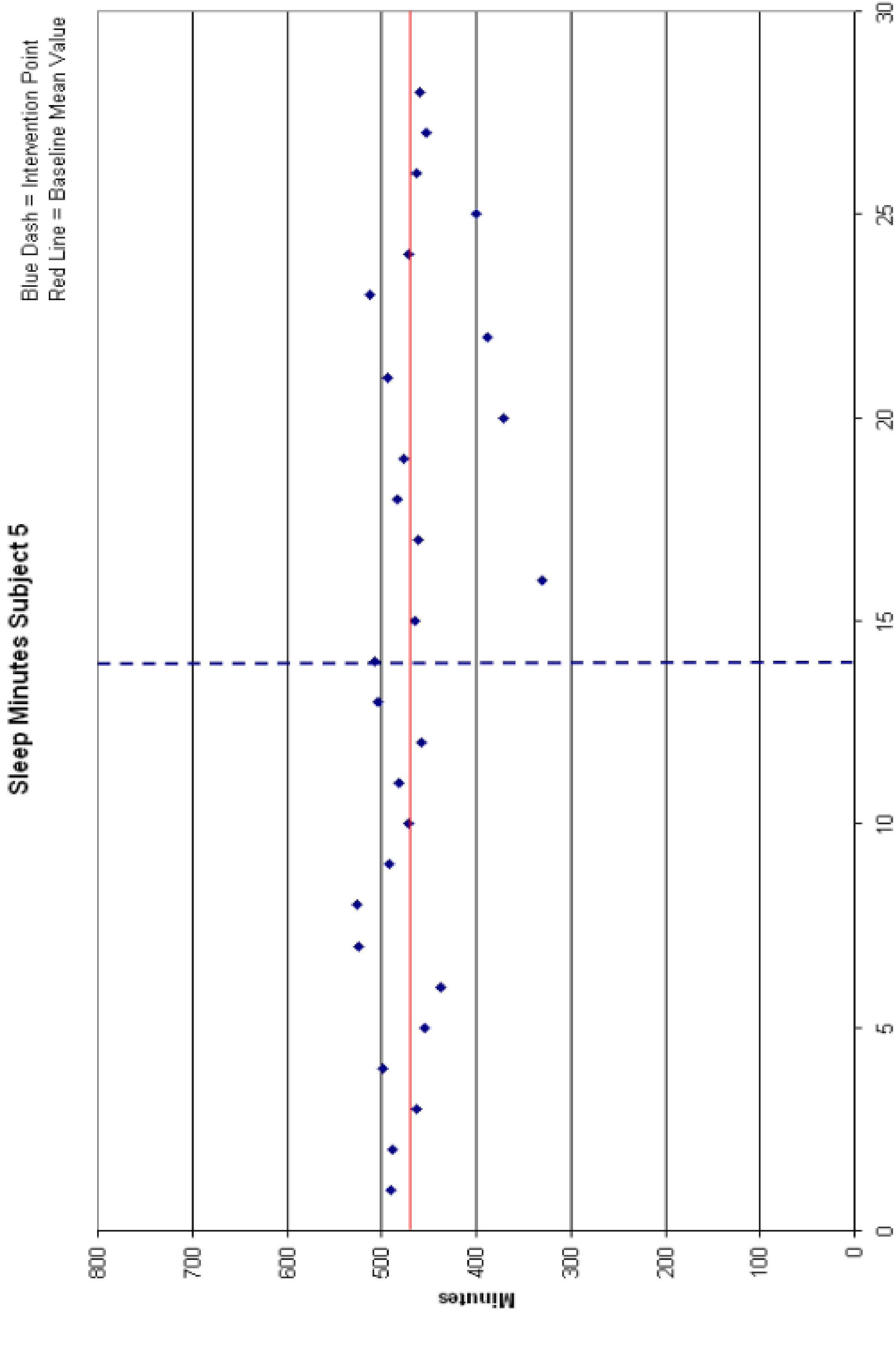

Sleep Minutes Subject 1
Blue Dash = Intervention Point
Red Line = Baseline Mean Value
Minutes
800
700
600
500
400
300
200
100
0
Day
0
5
10
15
20
25
30

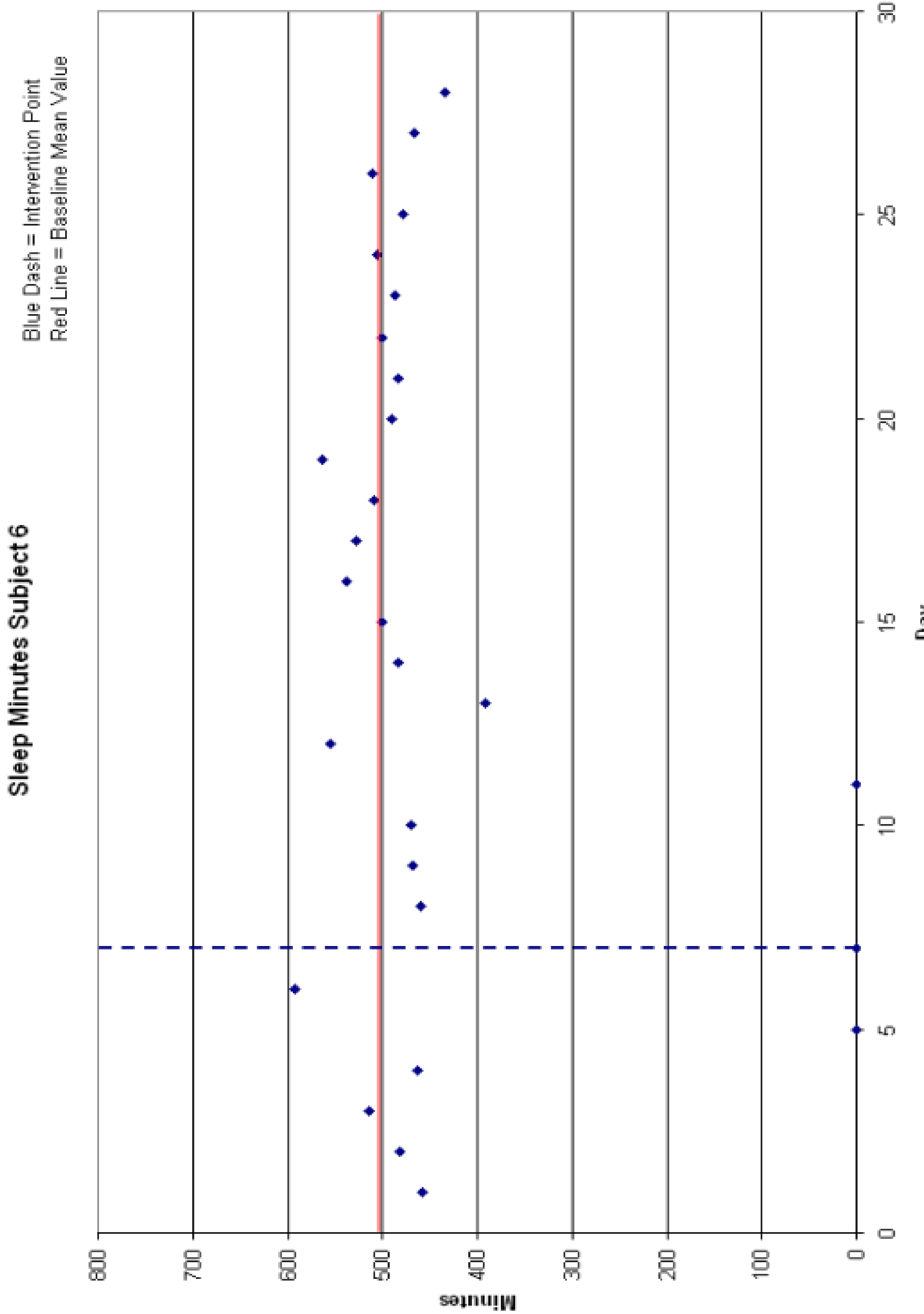


Sleep Minutes Subject 2
Blue Dash = Intervention Point
Red Line = Baseline Mean
Minutes
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Day


Sleep Minutes Subject 3
Blue Dash = Intervention Point
Red Line = Baseline Mean Value
Minutes
0
100
200
300
400
500
600
700
800
Day
0
5
10
15
20
25
30


Sleep Minutes Subject 4
Blue Dash = Intervention Point
Red Line = Baseline Mean Value
Minutes
Day
0
100
200
300
400
500
600
700
800
0
5
10
15
20
25
30


Sleep Minutes Subject 5
Blue Dash = Intervention Point
Red Line = Baseline Mean Value
Minutes
Day
0
100
200
300
400
500
600
700
800
0
5
10
15
20
25
30


Sleep Minutes Subject 6
Blue Dash = Intervention Point
Red Line = Baseline Mean Value
Minutes
0
100
200
300
400
500
600
700
800
Day
0
5
10
15
20
25
30